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FIRE SUPPORT COORDINATION: A SYSTEM ARCHITECTURE PERSPECTIVE

by

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Fire Support Coordination: A System Architecture Perspective

by

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The purpose of this thesis is twofold: first is to describe the current Marine Corps fire support system as an overall architecture and the second is to provide teaching materials for the Joint C3 curriculum. The emphasis will be to identify and illustrate the various command, control, and coordination procedures that are evident throughout the system. The system architecture described will provide a foundation from which the student will be required to design their own conceptual architecture. The command and control architecture of the fire support system is presented. A detailed analysis of the underlying C2 processes of the structure is conducted. A case is developed that will encourage the student towards the application of C2 concepts and principles. The author concludes with a description of methods used to evaluate an architecture.

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I. INTRODUCTION

A. GENERAL

The Fire Support Coordination System is a formal organization used by both the Navy and Marine Corps. Its primary purpose is to plan, coordinate, and execute fire plans that lead to the destruction of the enemy. It employs assets from a variety of supporting arms communities. Given that the next battlefield can be described as "target rich" and our expendable resources have limitations, the fire support system cannot possibly engage all the available targets on the battlefield. The fire support system must decide which targets warrant engagement and what is the best manner with which to attack those targets. The purpose of this thesis is to describe the current method of fire support coordination with respect to the command and control processes contained within. The focus will be on the application of C3 concepts, emphasizing organizational structure, process, and formal coordination to the fire support coordination system. The motivation for the thesis is to provide a current descriptive command and control architecture that provides the student an enhanced capability through which to exercise the concepts introduced in the Joint C3 curriculum. It is intended to furnish the

student with an architectural framework from which they can design an alternative architecture.

B. DEFINITIONS

The following relate Supporting Arms to the concept of Command, Control, and Coordination.

1. Supporting Arms Command

This is the authority which a commander in the military service exercises over supporting arms by virtue of rank or assignment. Command includes the authority and responsibility for effectively using available resources and for planning the employment of organizing, directing, coordinating, and controlling military forces for the accomplishment of assigned missions. [Ref. 1:p. 2]

2. Supporting Arms Control

This is the authority which may be less than full command exercised by a commander over supporting arms. [Ref. 1:p. 2]

3. Supporting Arms Coordination

This is the planning and executing of air, artillery, and naval gunfire so that targets are adequately covered by a suitable weapon or groups of weapons. [Ref. 1: p. 2]

C. ORGANIZATION OF THE THESIS

Chapter II contains background information on the organization and personnel involved in the fire support

coordination process. Readers familiar with current doctrine regarding fire support coordination may wish to scan these sections. Chapter III contains the major portion of the thesis, where the current fire support architecture is described. The concepts and principles of C2 are then applied to this fire support architecture in Chapter IV. Chapter V develops a framework case from which the student is required to design an alternative architecture. Finally, Chapter VI introduces some of the terms and methods associated with the evaluation of a system architecture.

II. PERSONNEL AND ORGANIZATIONAL STRUCTURE

A. ORGANIZATION BACKGROUND

The purpose of this chapter is to introduce and define the various agencies and personnel that comprise the fire support architecture and system for an amphibious environment. The first component part to be discussed is the same one that exists in all military organizations: the commander.

1. Commander Amphibious Task Force (CATF)

The individual initially responsible for the overall coordination of the delivery of supporting arms is the CATF. His duties and responsibilities mirror those defined in Chapter I under Supporting Arms Command. He is responsible for establishing the Supporting Arms Coordination Center (SACC) and for ensuring the preparation of the plans for the supporting arms elements. This individual is normally a Naval Officer holding the rank of Admiral. [Ref. 1:p. 1-2]

2. Commander Landing Force (CLF)

Prior to the establishrent of supporting arms agencies ashore the person ultimately responsible for the operation is the CATF. Upon the successful transfer of control ashore this responsibility is shifted to the CLF. CLF is normally a Marine General Officer who is also the commander of the Marine Air Ground Task Force (MAGTF). Prior to the

passage of command and control ashore CLF maintains close liaison with CATF to ensure the needs of his forces are met. He maintains an advisor's role with CATF and coordinates with him closely. [Ref. 1:p. 1-3]

3. <u>Supporting Arms Coordination Center (SACC)</u>

This is CATF's principle agency through which he exercises overall command and control of supporting arms. The SACC is responsible for coordinating the delivery of all supporting fires. The SACC consists of a naval gunfire section, an air support section, and a target information center. Figure 1 illustrates the setup of the SACC. [Ref. 2:p. 60-5]

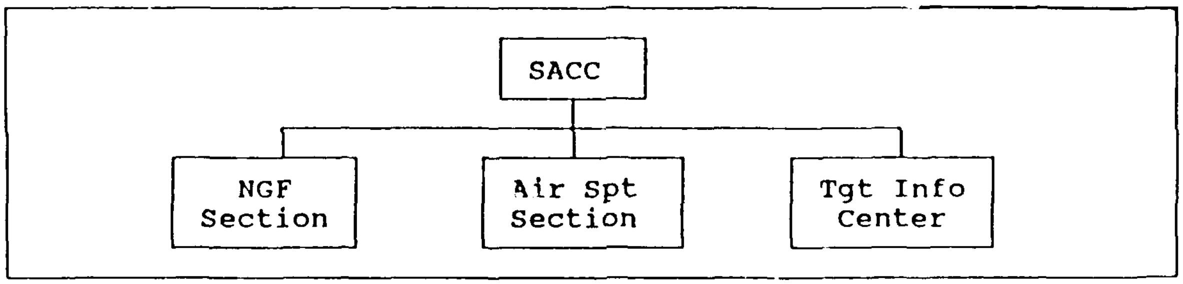


Figure 1. SACC Organization

The naval gunfire section is responsible for the planning and coordination of naval gunfire support and normally is organic to the CATF staff. The air support section coordinates the planning and exercises responsibility for all phases of antiair warfare, helicopter coordination, and

all air support for the amphibious operation. This section is not normally organic to the CATF staff. It is assigned from a Tactical Air Control Group Squadron. The Target Information Center is responsible for the acquisition and maintenance of target information and target intelligence. This section is normally organic to the staff. [Ref. 2: p. 60-5]

4. <u>Fire Support Coordination Center (FSCC)</u>

An important point is that the SACC is the Navy's supporting arms coordination agency. A number of the supporting arms assets used are Marine Corps. The Marine Corps has its own agency that is responsible for the coordination of supporting arms. This agency is called the Fire Support Coordination Center and it reports directly to the CLF. During the planning stages of the operation the SACC and FSCC are considered co-equals. During the afloat phase of the operation the FSCC and the SACC operate in close cooperation. Appropriate personnel of the FSCC are stationed within the SACC to provide for a rapid exchange of information and to expedite the processing and coordination of Landing Force fire support requests. [Ref. 1:p.3-2] The composition of the FSCC includes a fire support coordinator (FSC), and a number of supporting arms representatives. These representatives include an artillery representative, naval gunfire representative, an air representative and additional personnel to perform operations, develop target

operations, develop target information and provide communication functions. [Ref. 1:p. 3-2]

It is important to note that both the SACC and FSCC are responsible solely for the coordination of fire support plans and recommendations. They are advisorial and coordination agencies only and do not command any element. The responsibility of command remains with CATF and CLF. Figure 2 is provided to show the control and coordination relationships [Ref. 1:p. 1-4].

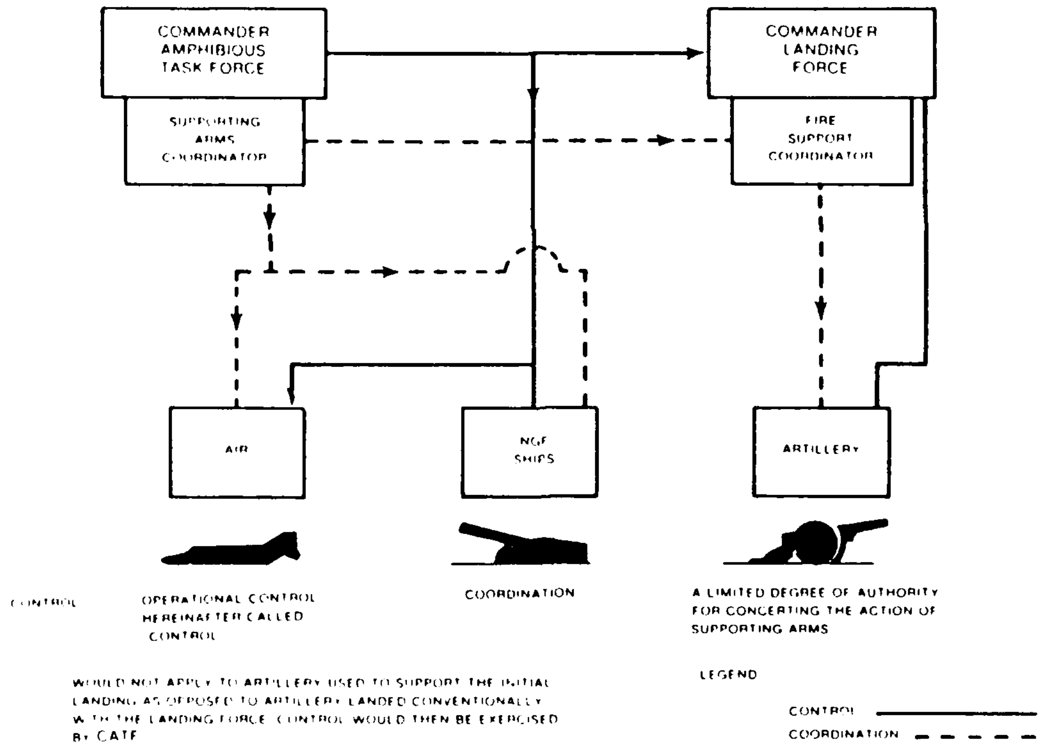


Figure 2. CATF/CLF Control and Coordination Relationships

5. <u>Tactical Air Command Center (TACC)</u>

Another important member of the fire support architecture is the Tactical Air Command Center. This is the senior air control and coordination in the amphibious operation. It provides for the supervision, coordination, and general control of all tactical air operations in the amphibious objective area. [Ref. 2:p. 68-9] The TACC is not located within the SACC but provides liaison to it. To conduct efficient air operations the TACC is organized into five sections.

a. Air Traffic Control Section

The Air Traffic Control Section performs a similar function to that of a civilian air traffic controller. Additionally, it is responsible for search and rescue operations. [Ref. 2:p. 68-11]

b. Air Support Control Section

This section coordinates offensive air support. Its primary responsibility is to support, advise, and assist the SACC. Additionally, it processes requests for close air support. [Ref. 2:p. 68-11]

c. Helicopter Coordination Section

This section's primary responsibility is to coordinate all helicopter operations conducted in the amphibious objective area. It also is the primary advisor to the SACC concerning the employment of helicopters. [Ref. 2:p.68-11]

d. AntiAir Warfare Section

This section's primary responsibility is to coordinate the antiair warfare effort. This section is additionally responsible for coordinating air defense with the SACC. [Ref. 2:p. 68-11]

e. Plans and Support Section

This section provides the planning, administrative, and communication support for all of the TACC sections. [Ref. 2:p. 68-12]

In addition to the sections comprising the TACC itself, there are also some subordinate agencies that function under the TACC's control.

f. Tactical Air Direction Center (TADC)

The Tactical Air Direction Center performs functions and duties similar to that of the TACC but in a specified area of responsibility. It has the additional responsibility and capability of assuming the responsibilities and role of the TACC. This can occur during advance force operations or in other sectors where the extreme separation of elements of the force warrants the establishment of a TADC. [Ref. 2:p. 68-13]

g. Direct Air Support Center (DASC)

The Direct Air Support Center is the principal air direction and control agency responsible for tactical air operations directly supporting ground forces. It is

normally the first air coordination agency ashore during the amphibious assault. [Ref. 2:p. 68-13]

h. Helicopter Direction Center (HDC)

The Helicopter Direction Center is the air operations agency under the supervision of the TACC that controls and directs helicopter operations. The HDC's primary responsibility is to control the movement of all helicopters operating within its assigned areas. [Ref. 2: p. 68-14]

i. Summary

This has been an overview of the air agencies that support CATF and coordinate with SACC to enable safe and effective air support operations. Figure 3 is included to illustrate the layout of the TACC [Ref. 2:p. 68-15].

6. <u>Joint Intelligence Center (JIC)</u>

The last major element of the supporting arms architecture is the Joint Intelligence Center. This is an intelligence gathering, processing organization that combines the intelligence assets of the Navy and the Marine Corps. This is done in order to facilitate close coordination between all communities and it enables the consolidation of intelligence assets and materials. [Ref. 5:p. 2-10] JIC's main purpose is to collect, process, and disseminate intelligence to the elements of the amphibious task force. The JIC is organized into a number of sections and subsections.

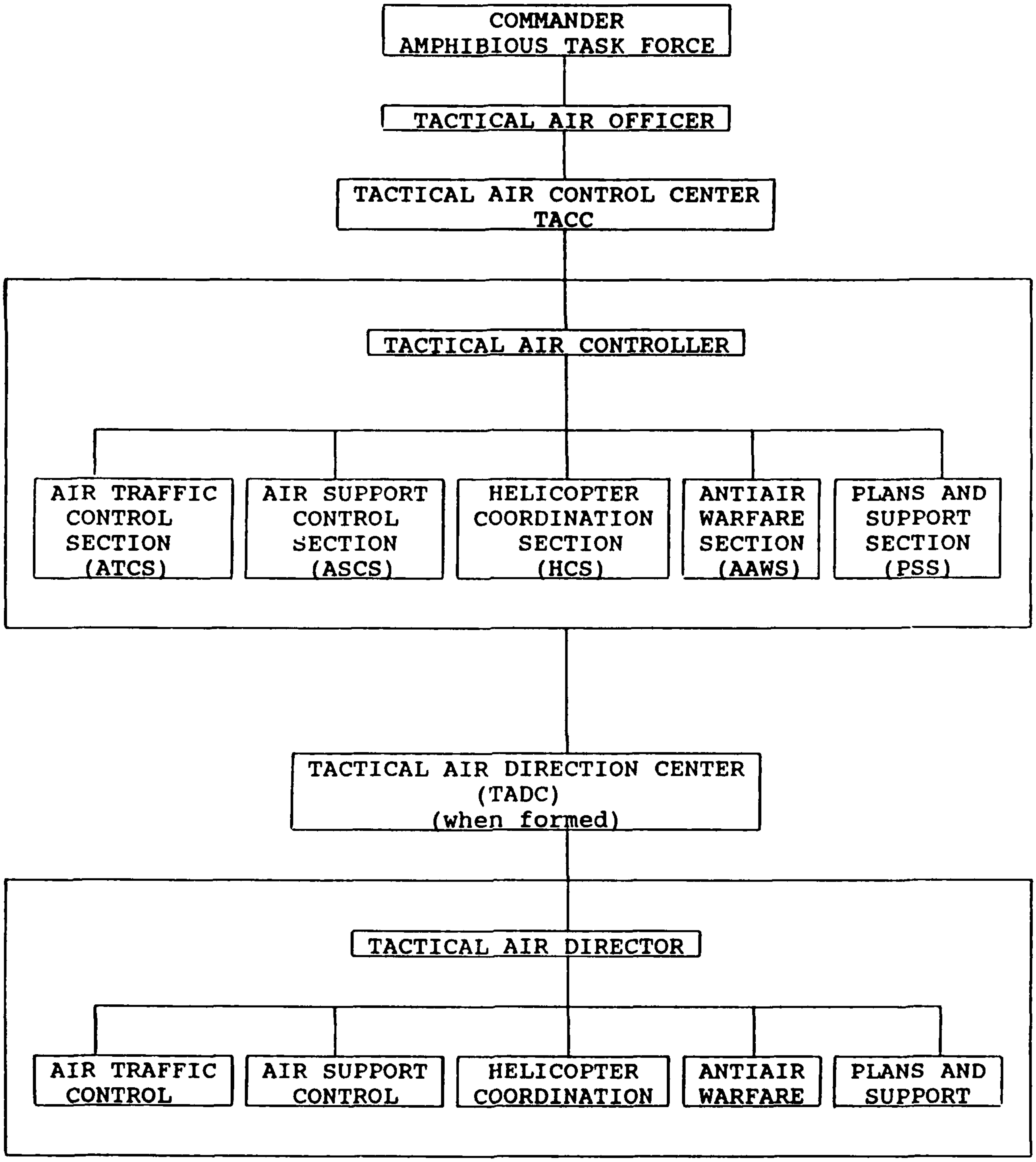


Figure 3. Organization of TACC and TADC

a. Sections Analysis Center

This is the primary section responsible for the processing of information into intelligence and the dissemination of that intelligence. It also is responsible for conducting the intelligence analysis of the situation to provide input for the operations plan. [Ref. 2:p. 5-4] This section is further divided into three subsections.

(1) Navy Section. This section is responsible for all the naval intelligence required for the protection of the amphibious task force.

(2) Ground Section. This section is responsible for the analysis of all ground intelligence that could affect operations ashore.

(3) Air Section. This section is responsible for the intelligence analysis of all activity dealing with enemy air assets. [Ref. 2:p. 5-5]

b. Collection and Requirements Section

This section is responsible for the management and tasking of intelligence collection assets organic to the amphibious task force. The section is additionally responsible for requesting collection by external activities. [Ref. 2:p. 5-5]

c. Imagery Interpretation Section

This section is responsible for interpreting and analyzing imagery and providing the derived intelligence to the JIC. [Ref. 2:p. 5-6]

d. Storage and Retrieval Section

This is the section that basically provides the data processing capability. This capability will be used to store and retrieve tactical information in support of the intelligence analysis effort. [Ref. 2:p. 5-6]

e. Target Information Center

This section is located in the SACC. It provides intelligence liaison to the SACC. Its main purpose is to provide intelligence data in order to identify likely targets for attack by the amphibious task force. This section also is responsible for establishing the target list for the task force. [Ref. 2:p. 5-6]

f. Administration Section

This section provides the overall clerical assistance to the JIC. [Ref. 2:p. 5-7]

g. Counter-Intelligence Section

This section directs, processes, and provides input on all counter-intelligence matters. [Ref. 2:p. 5-7]

h. Naval Special Warfare Intelligence Section

This section prepares the target and mission folders that will be used during operations conducted by the special warfare teams. [Ref. 2:p. 5-7]

i. Joint Intelligence Center Electronic Warfare Analysis and Coordination Center (JICEWACC)

This section is responsible for the planning, coordination, and management of the signal's intelligence effort for the task force. [Ref. 2:p. 5-7]

j. Joint Ship's Exploitation Space

This section provides the communication support necessary to use cryptologic electronic support measures (CESM) and special intelligence assets. [Ref. 2:p. 5-8]

k. Joint Electronic Warfare Coordination Center

This section is responsible for the planning and coordination of electronic warfare assets used by the task force. [Ref. 2:p. 5-8] Figure 4 depicts the various personnel and sections that comprise the JIC [Ref. 2:p. 5-9].

7. Summary

This section has outlined the purpose and organizational structure of the command, control, and coordination elements for an amphibious task force. As one can see there are a number of agencies involved in this process and they vary in depth and complexity. It is important to note that the organization of the previous listed agencies are notional and are only given to provide a basis for understanding the overall architecture. Many of the actual structures are task organized to fit a specific situation but will be similar to the one described.

B. PERSONNEL BACKGROUND

As depicted in the previous section there are a number of organizations involved within the architecture. This implies that an extensive amount of coordination must take place between personnel assigned to these organizations.

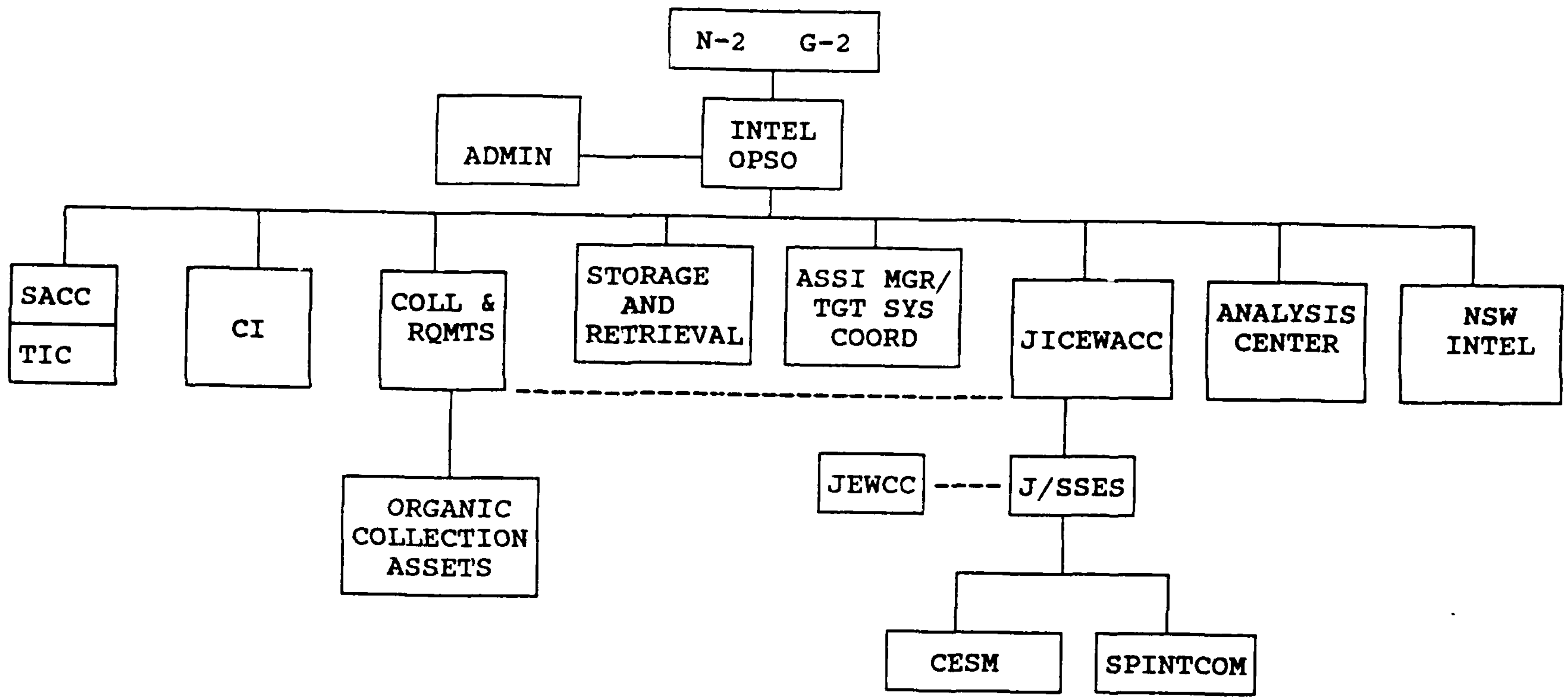


Figure 4. Organization of Joint Intelligence Center

This section will describe the functions and duties of some of the personnel involved in this process. This section will focus on the personnel involved in the operations of the SACC and FSCC.

1. Supporting Arms Coordinator/Fire Support Coordinator (SAC/FSC)

Both the Supporting Arms Coordinator and the Fire Support Coordinator have similar duties and responsibilities and will be discussed together. They are responsible for organizing, training, and supervising the members of their centers. They both perform duties that center around the planning and coordination of fire support. Specifically, their duties include:

- Advising the Commander on all matters pertaining to fire support.
- Preparing the overall fire support plan developed from the Commanders' concept of operation.
- Recommends fire support coordination measures.
- Provides clearance on requests for fire support and deconflicts any problems that may arise.
- Disseminates target information to those requiring the information.
- Advising the Commander on the selection of targets and recommends target attack precedence. [Ref. 3:pp. 2-4--2-7]

2. Naval Gunfire Control Office and Naval Gunfire Representative

The Naval Gunfire Control Officer is a CATF asset. The Naval Gunfire Representative comes from the CLF. They

both perform essentially the same duties. Specifically their duties are:

- Determining requirements for naval gunfire support through analysis of the operation plan.
- Preparing and processing requests for naval gunfire support.
- Performing target analyses.
- Assisting in the coordination and integration of naval gunfire with other supporting fires.
- Maintaining up to date information regarding the status of naval gunfire support and its available supply of ammunition. [Ref. 4:p. 2-6]

3. <u>Artillery Representative</u>

This individual keeps the SAC/FSC appraised of:

- The nuclear, chemical, and conventional capabilities of supporting artillery.
- The actual artillery support that has been rendered.
- The ammunition availability status.
- His recommendations and information regarding clearances and coordination of artillery missions. [Ref. 1: p. 3-6]

4. <u>Air Representative</u>

This individual keeps the SAC/FSC appraised of:

- The nuclear, chemical, and conventional capabilities of air support.
- The actual air support that has been rendered.
- Ordnance and ammunition restrictions and policies which may affect the availability of air support.
- Recommendations and information of fire support matters related to air support.
- Probable changes or modifications to planned air support due to weather, aircraft availability, or enemy air threat. [Ref. 1:p. 3-8]

These have been some specific duties that the various supporting arms representatives to the SACC/FSCC are responsible for. This next list is a summation of duties that are common to each of them. Common duties:

- Advising the FSC/SAC on capabilities and limitations of his supporting arm.
- Assists in the preparation of the overall fire support plan.
- Keeps the TIO advised of all target information received through his channels.
- Provides input from his own supporting arm to the FSC/SAC as he develops fire support coordination measures. [Ref. 3:p. 2-5]

5. Target Intelligence Officer

His duties encompass assisting and advising in matters concerning target acquisition, the collection of target information, the production of target intelligence, and the consolidation and dissemination of target intelligence. Additionally, he is responsible to maintain close liaison with the target information officer to ensure a timely and continuous exchange of information and target intelligence. [Ref. 5:p. 12-4]

6. Target Information Officer (TIO)

The TIO is responsible for the following:

- Keeping the FSC/SAC informed of the status of targets.
- Supervising the operation of the Target Information Center.
- Advising and assisting the FSC/SAC in the preparation of the amphibious task force target list.

- Advises and assists in the selection of ordnance to be employed against specific targets.
- Maintains close liaison with the Target Intelligence Officer. [Ref. 5:p. 12-5]

This section has described the various duties and responsibilities of members of the SACC/FSCC. The Naval and Marine Corps personnel were often included together because their respective duties are similar. An important final note for this chapter is that while the SACC is functioning the SAC has overall responsibility for its operation while members from the Landing Force (Marines) provide assistance and guidance. Figure 5, a functional diagram of the organization of the SACC is provided on the following page [Ref. 1:p. 1-5].

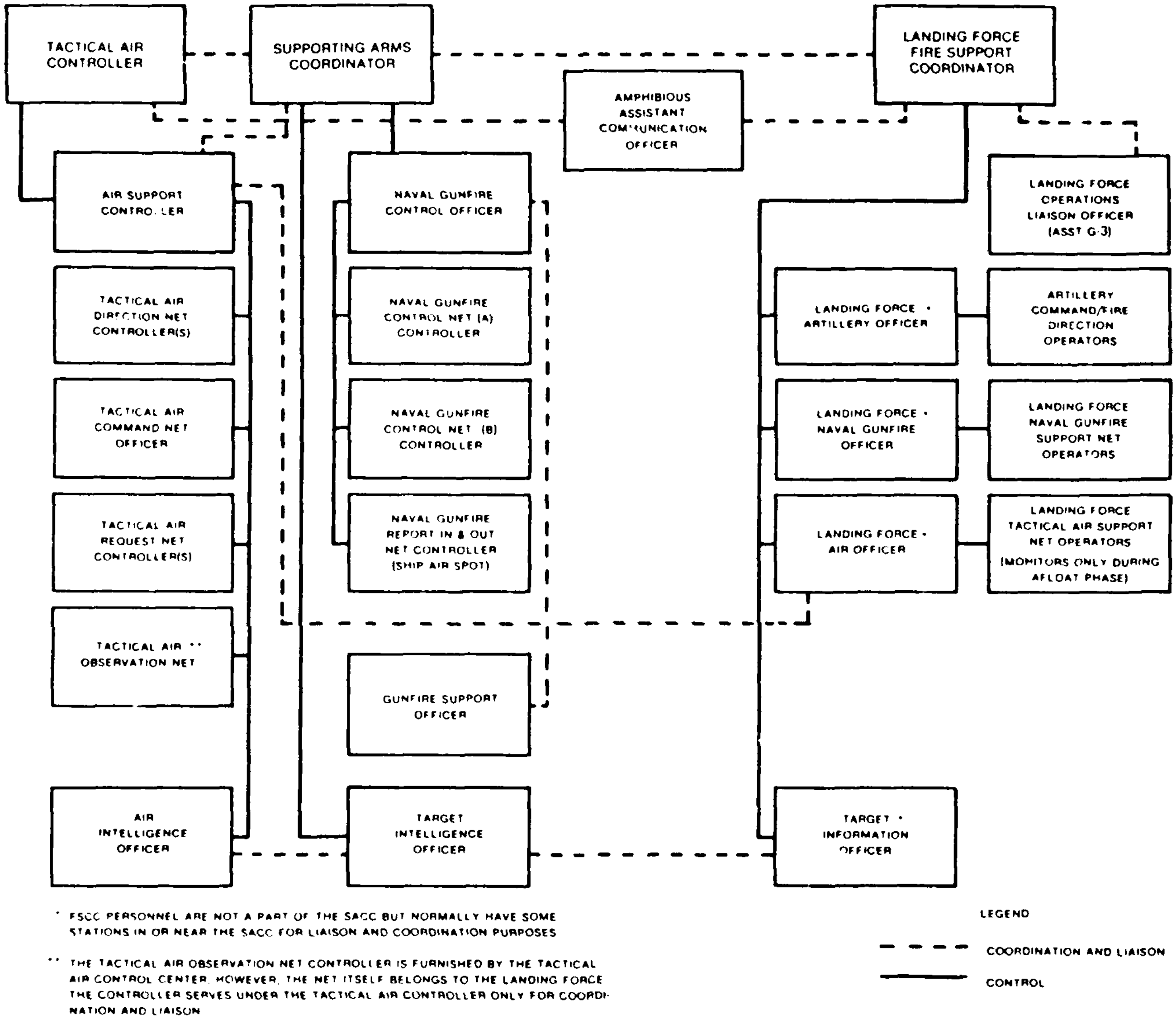


Figure 5. Organization of Supporting Arms Coordination Center

III. THE PROCESS ARCHITECTURE

A. BACKGROUND

Command and Control systems architecture has been described as having a three dimensional approach. According to JCS publications one and two definition, a C2 system consists of:

- Physical entities (equipment, software, people and their associated facilities).
- Structure (organization, concepts of operation) including procedures and protocols.
- Processes (the functionality of what the system is doing). [Ref. 6:p. 12]

This definition can be related to the architecture of the SACC/FSCC. The physical entities associated with the fire support system would include such items as weapons, software, personnel, communications equipment, etc. The structure of the system and its organizational attributes were described in Chapter II. The emphasis of this chapter will be on the third element of the C2 system; the processes. What are the underlying processes that function throughout the architecture that enable the system to work effectively? The internal C2 processing functions that characterize what the system is doing will be discussed next. The personnel and basic organizational structure that were described in Chapter II are the skeleton of the overall system with the heart being the coordination processes.

B. PROCESS ARCHITECTURE

Figure 6 is an overall schematic of the process organization. This figure should be referred to as the various component parts are discussed. Using a top-down approach the peak of the structure is the commanding officer. As in any military organization, this individual is the one ultimately responsible for everything the unit does or fails to do. The rest of the architecture is organized to show that there are four major procedures that form the basis of the fire support architecture. The four processes are coordination, weapons, processing, and sensing.

1. Weapons Unit

This is a generic unit that is used to depict an organizational headquarters for any one of the supporting arms units assigned to the fire support process. This unit's primary purpose is to maintain command and control of the supporting arm under its direction. This is the element of the supporting arms architecture that delivers the output for the system. The output for this unit is some type of targeted energy upon a target of opportunity.

a. Weapons

This next level down represents the organization of the weapons themselves. This level depicts the last organizational command structure in the weapons chain. This level would be analogous to an artillery battery

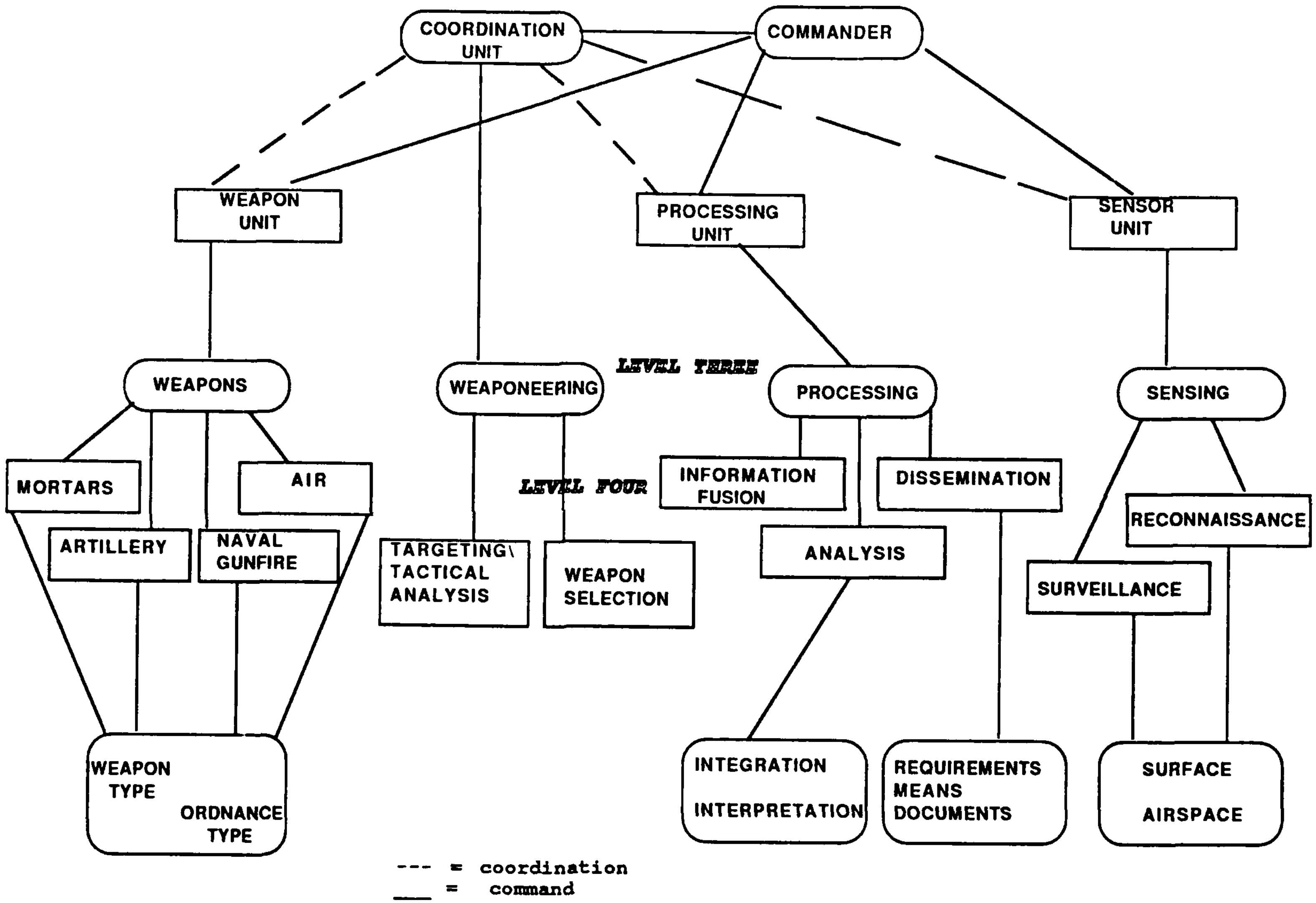


Figure 6. Overall Process Architecture

headquarters or a fire support ship. The specific purpose is to direct the fires of the resources under its command.

b. Level Three

This level represents the various types of weapons that are normally associated with the fire support architecture. As depicted in Figure 6, the various weapon types include mortars, close air support (fixed wing and rotary), field artillery, and naval gunfire support assets. The purpose of this level is to execute the fire command and deliver force upon a target.

c. Level Four

The final level in the weapons process chain is included to show that there are a multitude of choices to be made prior to delivery of a weapon on a target. Within each weapons family there are a variety of calibers or types of weapons that can be selected. Additionally, with each weapons type there is a wide range of ordnance to choose from each possessing a different capability. For example, an artillery battalion has the capability of delivering rounds ranging from 105mm to 155mm and in some cases 203mm. In conjunction with these various calibers is a wealth of ordnance options. A short list would include such options as High Explosive (HE), White Phosphorous (WP), Chemical, and Nuclear. Additionally, the other family of weapons (air, naval gunfire, mortars) have an extensive variety of choices as well.

An overall example of what a typical weapons process would include is:

- Weapons Unit = Artillery Battalion Headquarters.
- Weapons = Artillery Battery.
- Level Three = The Howitzers.
- Level Four = A 155mm, High Explosive Round (HE).

2. Processing Unit

This is the organizational headquarters for the second of the four major processes. This unit is representative of the JIC organizational structure. The units main purpose is to direct and coordinate the intelligence assets assigned to the task force. Direction encompasses the following steps:

- Determination of intelligence requirements.
- Preparation of a collection plan.
- Issuance of orders and requests to collection agencies.
- Supervision and coordination of the processing cycle. [Ref. 5:p. 4-1]

a. Level Three--Processing

Processing is the task of converting information into intelligence. It accomplishes this by systematically:

- Recording information.
- Evaluating information to determine its pertinence.
- Analyzing information to isolate significant events.
- Integrating the information.
- Interpreting the information. [Ref. 5:p. 7-1]

b. Level Four

The process listed above is accomplished through the course of three subprocesses.

(1) Information Fusion. This is a process through which elements of information are combined and blended to form one product of useful intelligence.

(2) Analysis. This subprocess involves the sifting and sorting of fused information to isolate significant events related to the mission. [Ref. 5:p. 7-8] Two component parts of the analysis subprocess are the integration and interpretation of information. Integration involves the combination of elements isolated in analysis to enable the intelligence officer to develop hypotheses about the enemy force. The purpose of interpretation is to determine the significance and meaning of the information and its possible effect on the operation and the intelligence estimate. [Ref. 5:p. 7-8]

(3) Dissemination. This is the last subprocess in the overall processing function. After an intelligence officer has transformed information into usable intelligence it must now be properly disseminated to the individuals who need the intelligence. There are three functional elements of the dissemination subprocess. The first is the Requirements Function. This function ensures that the dissemination of the intelligence is timely, pertinent, and secure. [Ref. 5:p. 8-1] Timely means it gets to a user in

an expeditious enough manner that it is useful. Pertinent means that it is disseminated only to those who really need that particular item of intelligence. This function must be secure enough that the enemy does not realize that friendly forces have gained this knowledge and subsequently alters his plans, negating the friendly forces entire effort.

The second is the Means Function. The dissemination process needs to be aware of the various means of dissemination available (oral, written, contact) and select the appropriate means.

The third is the Documents Function. This entire process must be documented to establish a base from which current operations can be positively influenced and from which future operations can draw information from.

3. Sensor Unit

This is the organizational headquarters for the third major process that is depicted in Figure 6. Its primary purpose is to direct the collection of intelligence effort. This unit will coordinate a large and diverse array of assets. Many of the assets utilized will not be organic to the task force and will require much coordination and liaison. This unit is configured to systematically sense for information pertinent to a given intelligence problem. The data acquired from the sensing effort results in the identification of enemy targets and activities that might

otherwise have gone undetected. The sensing effort is comprised of two key elements.

a. Level Three--Sensing

This level depicts the actual process of sensing. The sensing effort should be carefully planned and most importantly it should be specific to the needs of the operational mission. The sensing process needs to consider the enemy situation and must carefully analyze weather and terrain factors that can affect its performance.

b. Level Four

(1) Reconnaissance. The definition of reconnaissance is,

> A mission undertaken, to obtain by visual observation or other detection methods, information about the activities and resources of an enemy or potential; or to secure data concerning the meteorological, hydrographic, or geographic characteristics of a particular area. [Ref. 7:p. 286]

Reconnaissance is a directed, sensing effort with a goal to obtain specific information about a given subject. An example of a reconnaissance effort would be an infantry patrol sent out to obtain information about the strength of an enemy unit.

(2) Surveillance. The definition of surveillance is, "The systematic observation of aerospace, surface, or subsurface areas, places, persons, or things by visual, aural, electronic, photographic, or other means." [Ref. 7:p. 335] Surveillance encompasses all techniques of accomplishing a continuous (i.e., all weather, day or night)

systematic watch over the objective area and enemy activities to provide timely information for the intelligence effort. [Ref. 5:p. 10-1] Surveillance is different from reconnaissance because it is not given a specific time constrained mission. Surveillance is involved with the continuous observation of an area or entity to monitor it for any significant changes in its posture. [Ref. 5:p. 10-2]

(3) Functional Elements--Surface and Airspace. Reconnaissance and surveillance of surface areas is a collection effort directed to obtain information about a locality, area, enemy unit, or any specified area of terrain. This involves the use of ground, amphibious, aerial, and communications-electronics collection agencies. These agencies employ a variety of sensors, ranging from the human eye and ear to a variety of sophisticated electronic devices. [Ref. 5:p. 10-2]

Reconnaissance and surveillance of airspace is the action taken to obtain weather data in areas where weather reports are not available. It is also the systematic patrolling and observation of airspace. It uses electronic, visual, or other sensors primarily for the purpose of identifying and determining the movements of aircraft or missiles through the airspace. [Ref. 5:p. 10-2]

4. Coordination Unit

This is the section analogous to the SACC/FSCC. Its primary mission is to coordinate the efforts and assets of the other three processes (weapons, processing, sensor) and deliver its resources at the enemy to effectively accomplish its mission. Because the fire support available to the task force is a limited asset it must be used wisely and this is the units ultimate goal. The Coordination Unit receives information and intelligence from the other three processes in order to perform its most important function: Weaponeering.

a. Level Three--Weaponeering

This is the process that does an analysis of the target to determine which weapons will be effective against the target and the degree of damage it is possible to achieve with various types and quantities of ammunition. The weaponeer needs to decide what level of engagement (destruction, neutralization, suppression) will render the target ineffective. The Joint Munitions Effectiveness Manuals (JMEM) are the primary source for determining probable effects of weapons against various targets. [Ref. 3:p. 7-21]

b. Level Four

(1) Targeting/Tactical Analysis. This is the process that occurs after the weaponeering process has decided what level of fire support will be used to engage a

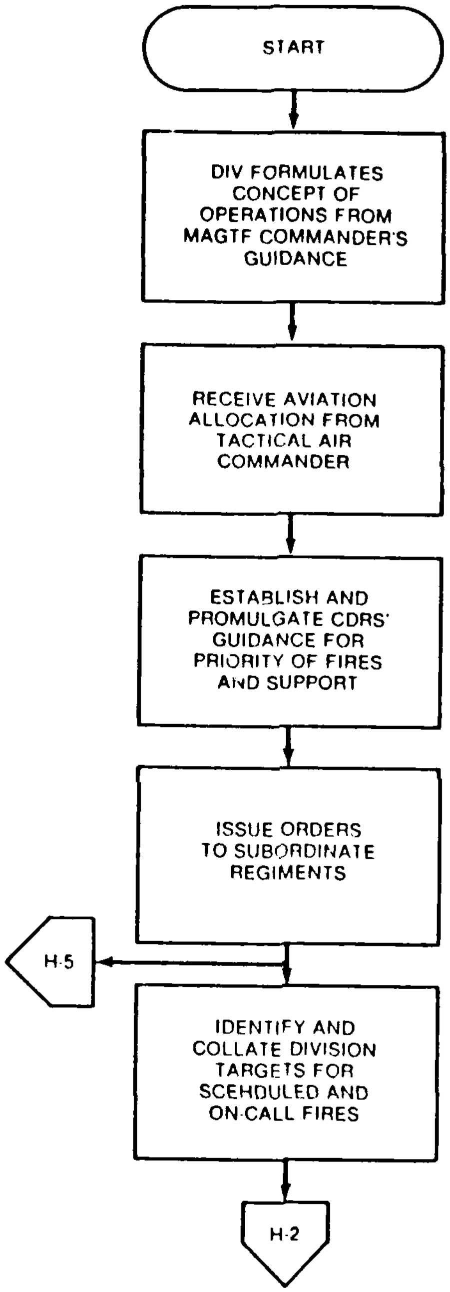
target and render it ineffective. This subprocess analyzes the target to determine its tactical significance. This means it should be weighed against the task force mission and objectives to see if this target can have a detrimental impact. The process must also carefully consider the tradeoffs involved in engaging the target, i.e., other potential targets that may not be attacked if this target is attacked. The last check in this process is to evaluate whether this target fits the parameters given in the Rules of Engagement (ROE). [Ref. 3:p. 7-22]

(2) Weapon Selection. The final subprocess is the actual weapon selection. Upon completion of this entire process, the appropriate weapon and level of fire support is determined. This decision is then transmitted to the Weapons Unit for execution.

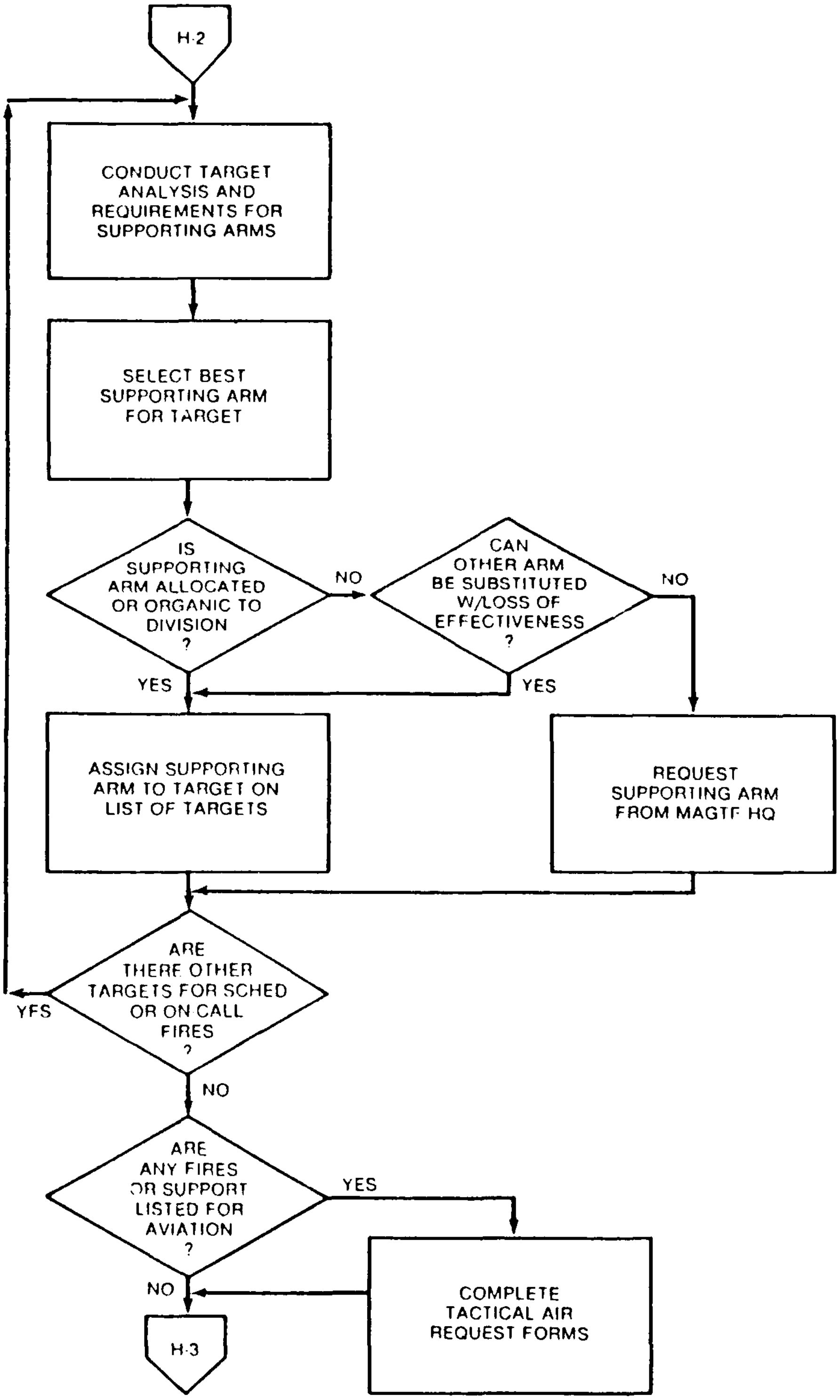
C. FIRE SUPPORT PLANNING PROCESS

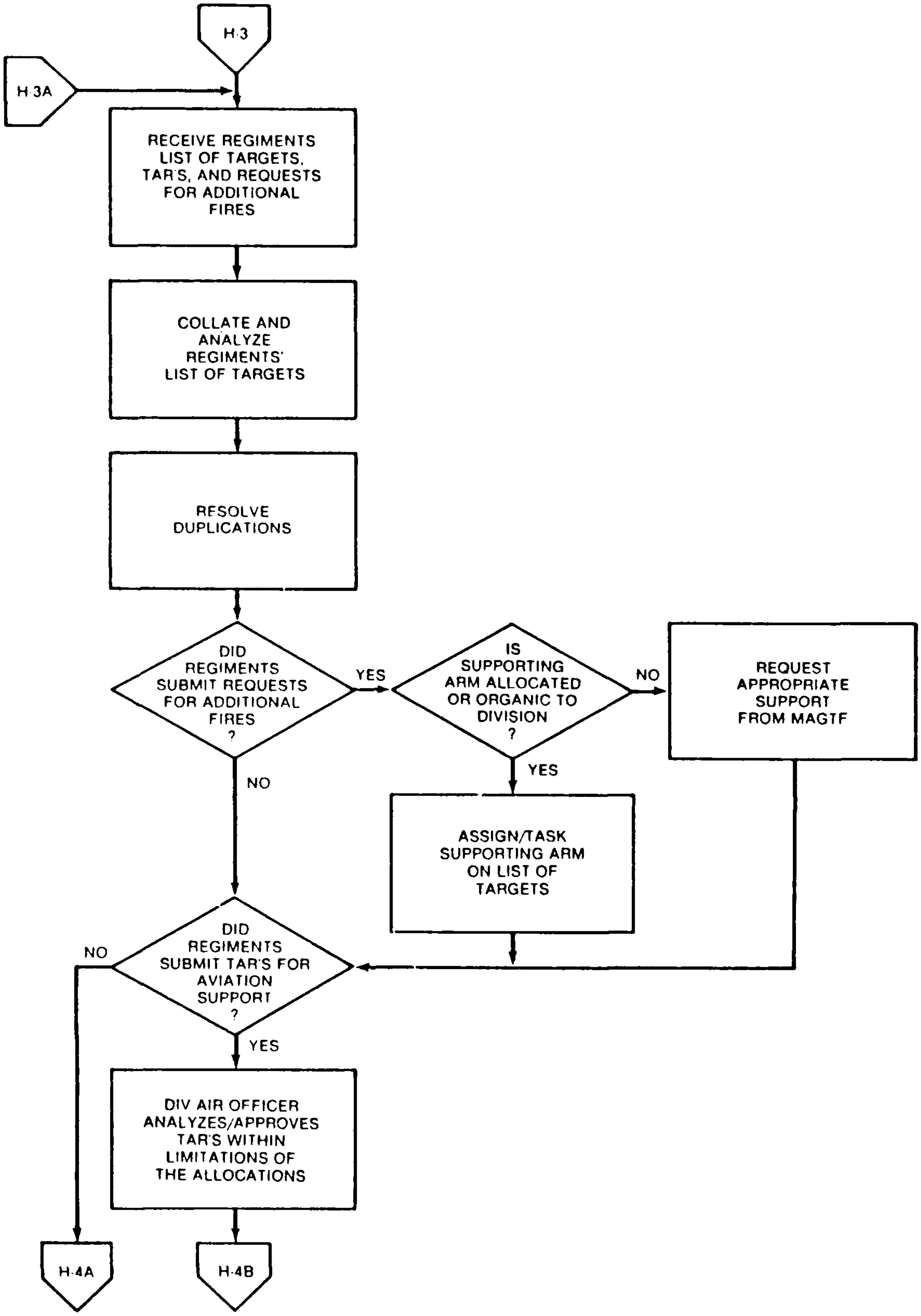
The following pages, through the use of a flow chart, illustrate the fire support planning process. These flow charts come from the Marine Corps doctrinal publication pertaining to fire support coordination [Ref. 1:pp.H-2--H-12]. The flow chart depicts the entire planning process from the initial concept of operation to the final development of a target list. They also point out the numerous decisions and processes that occur throughout the system. The chart is included so that a better understanding of the flow of information will develop.

The following is a synopsis of what is transpiring on each page of the flow charts. (On pages 33-43 below, the page reference from Reference 1 is indicated at the bottom of the page.) On page H-2 the planning cycle begins with the formulation of a concept of operation based on commanders guidance. Pages H-2 to H-12 represent the fire support planning process for a Marine Corps Division. It delineates the planning cycle for each organizational level of fire support coordination. Pages H-2 to H-5 represent the Division level. Pages H-6 to H-9 represent the Regimental level. Pages H-10 to H-12 represent the Battalion level of fire support planning. Each of these distinct steps perform similar steps in the planning cycle. The beginning of each loop (H-2, H-6, H-10) is where a determination of fire support requirements is developed concurrently with battle plans. Target lists and plans are consolidated and disseminated to subordinate units. The next step in each loop is the preliminary weaponeering stage (H-3, H-7, H-11). At this point the target is analyzed, the best supporting arm available is selected, and then the target is assigned to a target list and promulgated to the necessary units. The final stage in the planning cycles (H-5, H-9, H-12) is the consolidation phase. This step consolidates the requirements for fire support from higher, adjacent, and subordinate units. The output is a list of

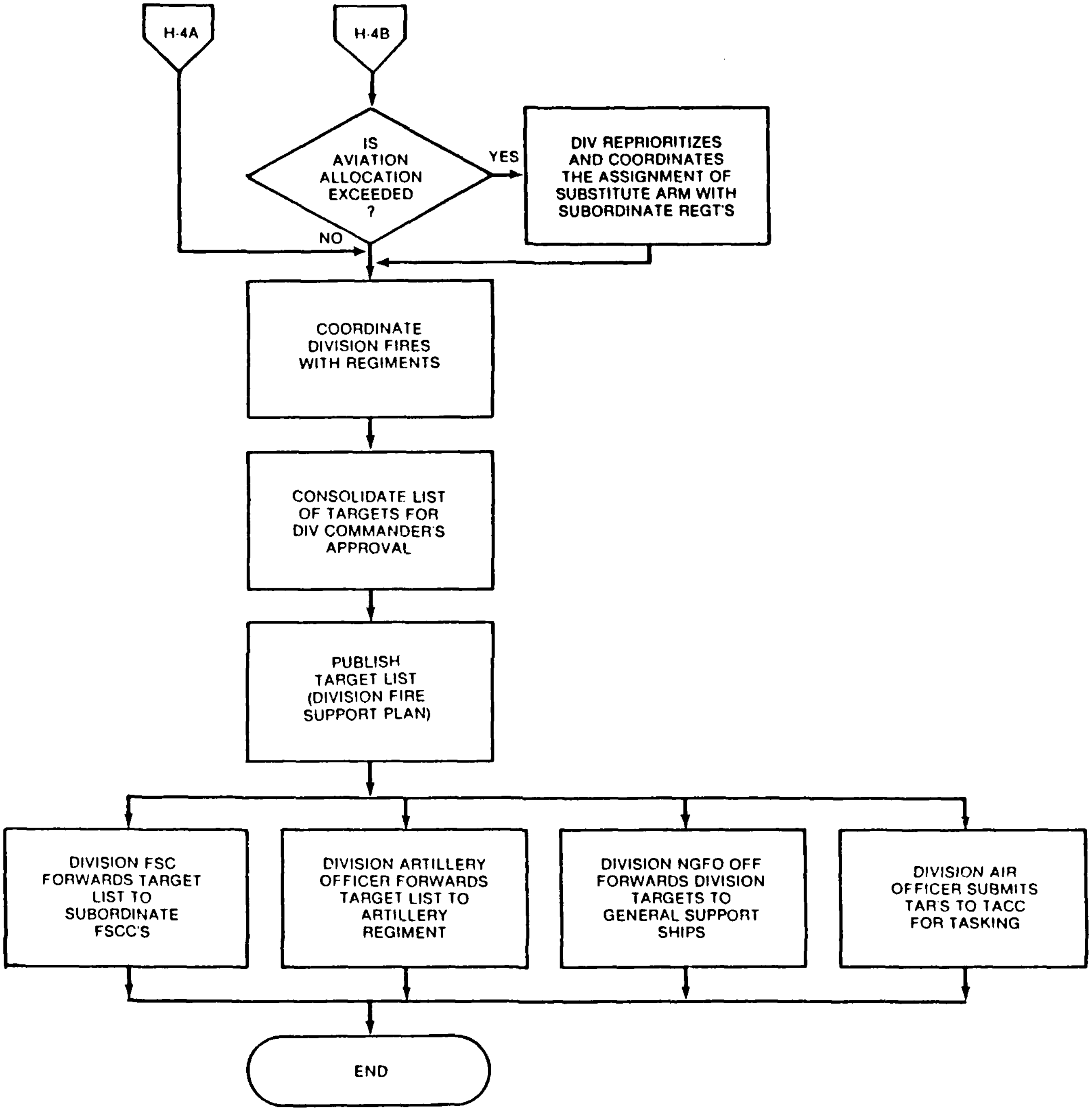

START
DIV FORMULATES CONCEPT OF OPERATIONS FROM MAGTF COMMANDER'S GUIDANCE
RECEIVE AVIATION ALLOCATION FROM TACTICAL AIR COMMANDER
ESTABLISH AND PROMULGATE CDRS' GUIDANCE FOR PRIORITY OF FIRES AND SUPPORT
ISSUE ORDERS TO SUBORDINATE REGIMENTS
H-5
IDENTIFY AND COLLATE DIVISION TARGETS FOR SCEHDULED AND ON-CALL FIRES
H-2

H-2

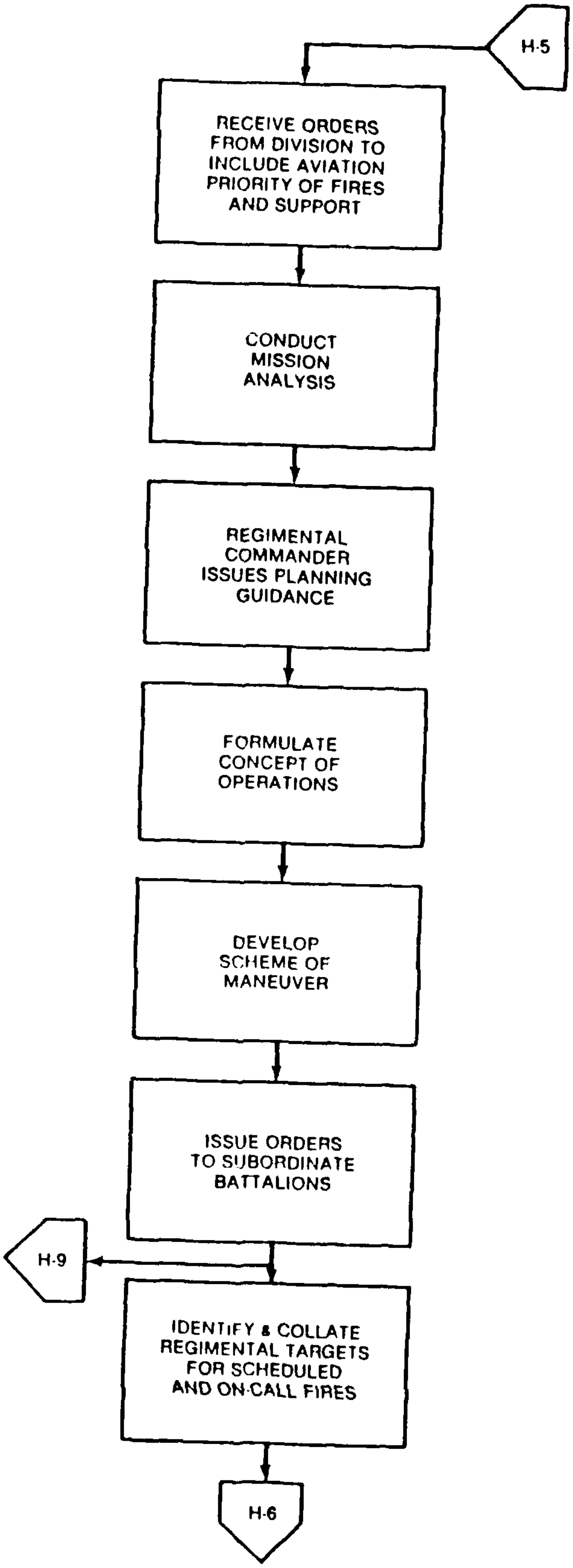

H-2
CONDUCT TARGET ANALYSIS AND REQUIREMENTS FOR SUPPORTING ARMS
SELECT BEST SUPPORTING ARM FOR TARGET
IS SUPPORTING ARM ALLOCATED OR ORGANIC TO DIVISION ?
NO
CAN OTHER ARM BE SUBSTITUTED W/LOSS OF EFFECTIVENESS ?
NO
YES
YES
ASSIGN SUPPORTING ARM TO TARGET ON LIST OF TARGETS
REQUEST SUPPORTING ARM FROM MAGTF HQ
ARE THERE OTHER TARGETS FOR SCHED OR ON CALL FIRES ?
YES
NO
ARE ANY FIRES OR SUPPORT LISTED FOR AVIATION ?
YES
NO
COMPLETE TACTICAL AIR REQUEST FORMS
H-3


H-3
H-3A
RECEIVE REGIMENTS LIST OF TARGETS, TAR'S, AND REQUESTS FOR ADDITIONAL FIRES
COLLATE AND ANALYZE REGIMENTS' LIST OF TARGETS
RESOLVE DUPLICATIONS
DID REGIMENTS SUBMIT REQUESTS FOR ADDITIONAL FIRES ?
YES
IS SUPPORTING ARM ALLOCATED OR ORGANIC TO DIVISION ?
NO
REQUEST APPROPRIATE SUPPORT FROM MAGTF
YES
ASSIGN/TASK SUPPORTING ARM ON LIST OF TARGETS
NO
DID REGIMENTS SUBMIT TAR'S FOR AVIATION SUPPORT ?
NO
YES
DIV AIR OFFICER ANALYZES/APPROVES TAR'S WITHIN LIMITATIONS OF THE ALLOCATIONS
H-4A
H-4B

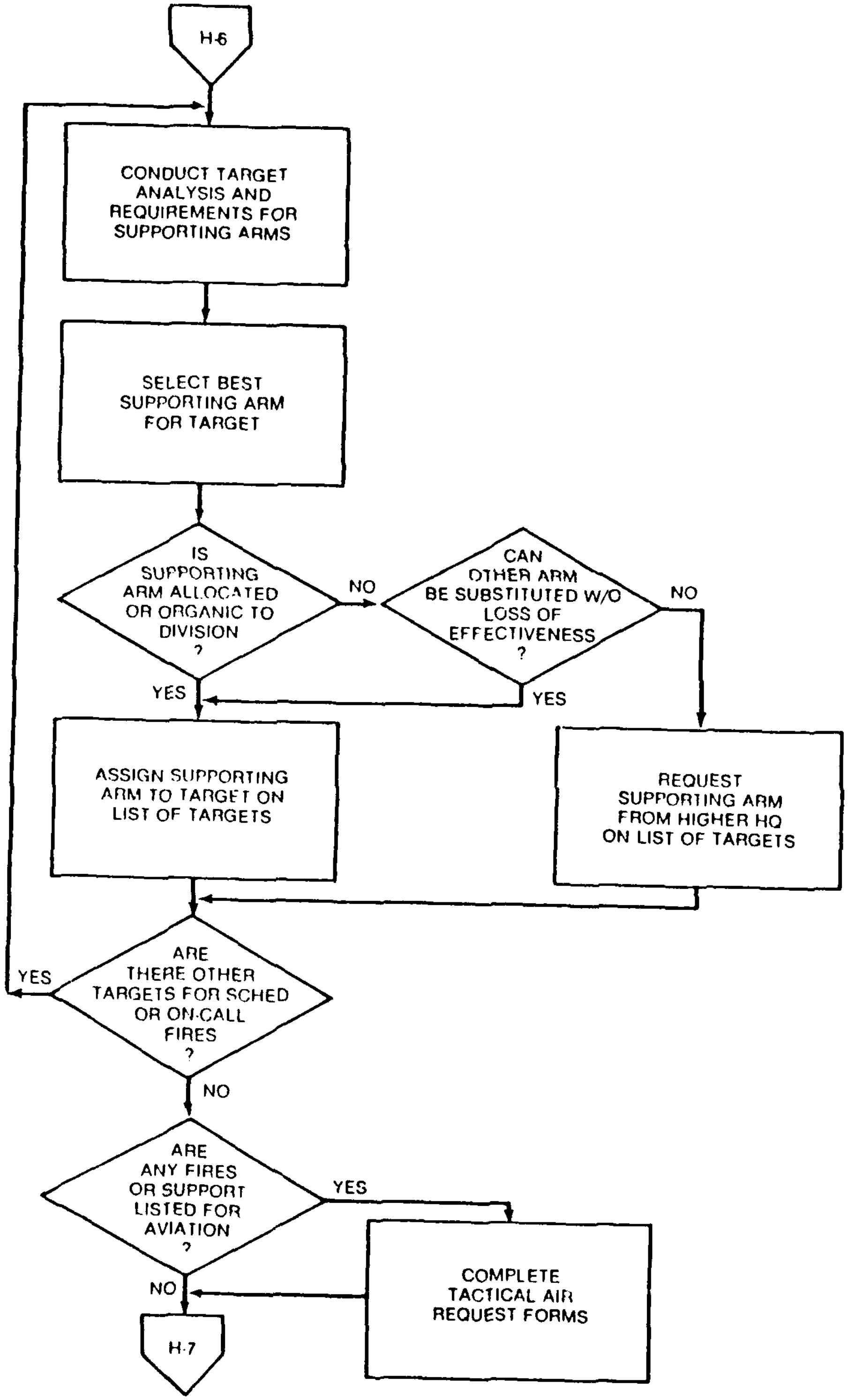
H-4


H-4A
H-4B
IS AVIATION ALLOCATION EXCEEDED ?
YES
NO
DIV REPRIORITIZES AND COORDINATES THE ASSIGNMENT OF SUBSTITUTE ARM WITH SUBORDINATE REGT'S
COORDINATE DIVISION FIRES WITH REGIMENTS
CONSOLIDATE LIST OF TARGETS FOR DIV COMMANDER'S APPROVAL
PUBLISH TARGET LIST (DIVISION FIRE SUPPORT PLAN)
DIVISION FSC FORWARDS TARGET LIST TO SUBORDINATE FSCC'S
DIVISION ARTILLERY OFFICER FORWARDS TARGET LIST TO ARTILLERY REGIMENT
DIVISION NGFO OFF FORWARDS DIVISION TARGETS TO GENERAL SUPPORT SHIPS
DIVISION AIR OFFICER SUBMITS TAR'S TO TACC FOR TASKING
END

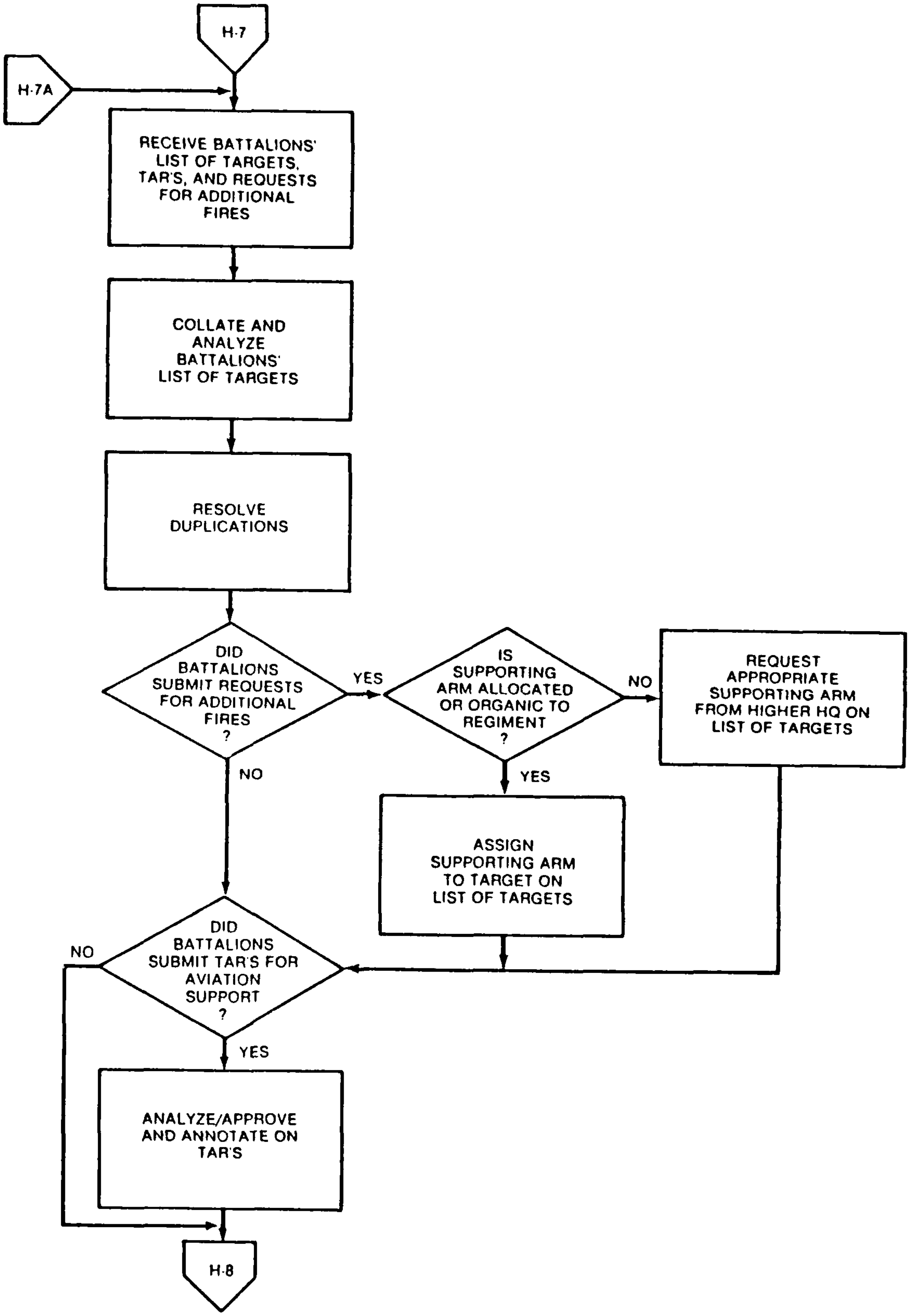
H-5


H-5
RECEIVE ORDERS FROM DIVISION TO INCLUDE AVIATION PRIORITY OF FIRES AND SUPPORT
CONDUCT MISSION ANALYSIS
REGIMENTAL COMMANDER ISSUES PLANNING GUIDANCE
FORMULATE CONCEPT OF OPERATIONS
DEVELOP SCHEME OF MANEUVER
ISSUE ORDERS TO SUBORDINATE BATTALIONS
H-9
IDENTIFY & COLLATE REGIMENTAL TARGETS FOR SCHEDULED AND ON-CALL FIRES
H-6

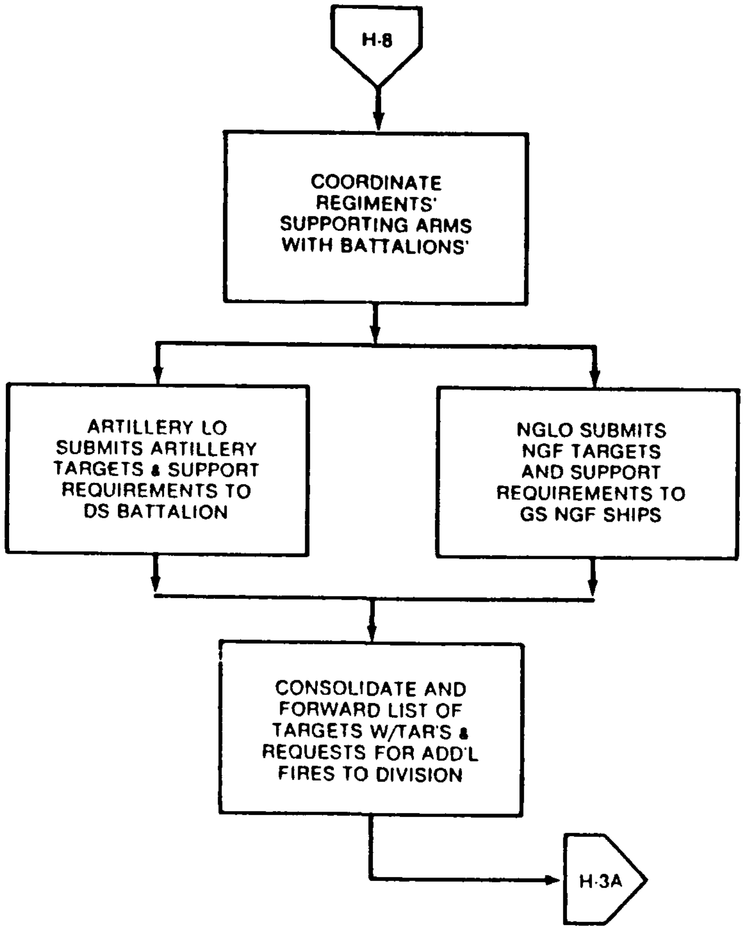
H-6

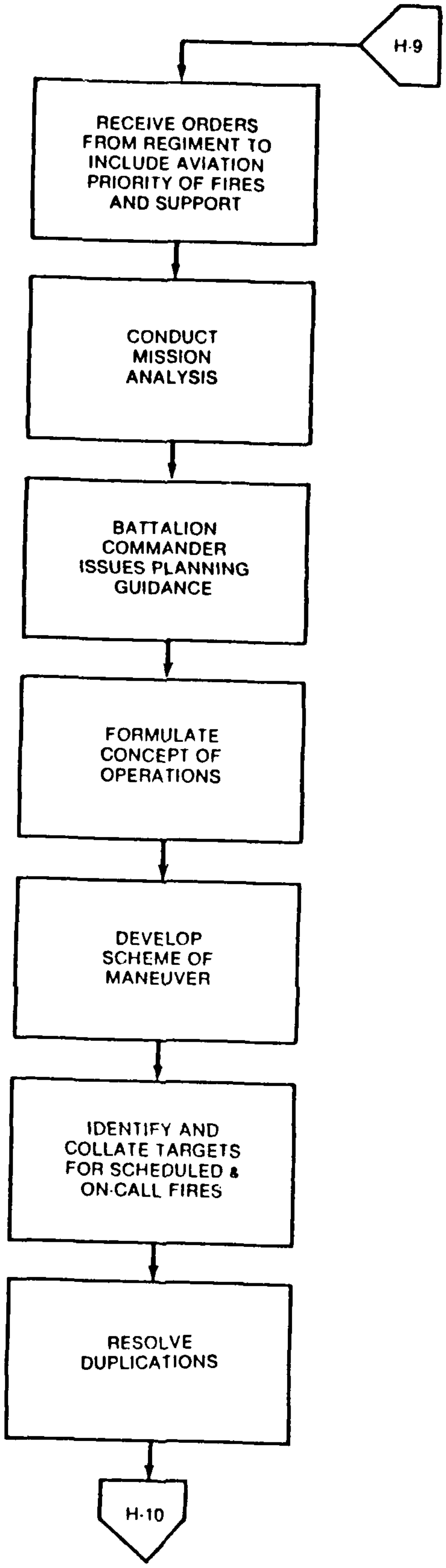

H-6
CONDUCT TARGET ANALYSIS AND REQUIREMENTS FOR SUPPORTING ARMS
SELECT BEST SUPPORTING ARM FOR TARGET
IS SUPPORTING ARM ALLOCATED OR ORGANIC TO DIVISION ?
NO
CAN OTHER ARM BE SUBSTITUTED W/O LOSS OF EFFECTIVENESS ?
NO
YES
YES
ASSIGN SUPPORTING ARM TO TARGET ON LIST OF TARGETS
REQUEST SUPPORTING ARM FROM HIGHER HQ ON LIST OF TARGETS
YES
ARE THERE OTHER TARGETS FOR SCHED OR ON-CALL FIRES ?
NO
ARE ANY FIRES OR SUPPORT LISTED FOR AVIATION ?
YES
COMPLETE TACTICAL AIR REQUEST FORMS
NO
H-7

H-7

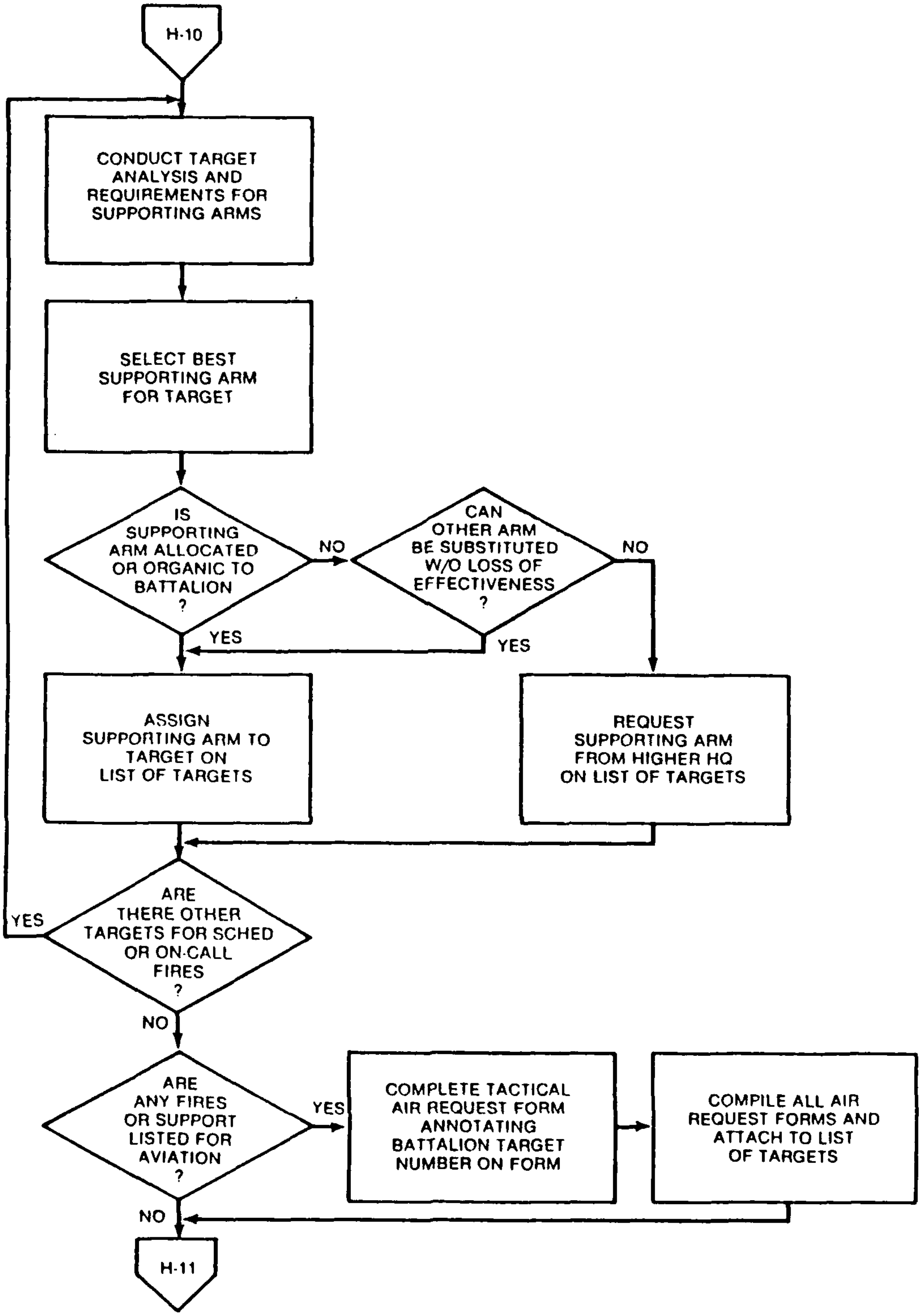

H-7
H-7A
RECEIVE BATTALIONS' LIST OF TARGETS, TAR'S, AND REQUESTS FOR ADDITIONAL FIRES
COLLATE AND ANALYZE BATTALIONS' LIST OF TARGETS
RESOLVE DUPLICATIONS
DID BATTALIONS SUBMIT REQUESTS FOR ADDITIONAL FIRES ?
YES
IS SUPPORTING ARM ALLOCATED OR ORGANIC TO REGIMENT ?
NO
REQUEST APPROPRIATE SUPPORTING ARM FROM HIGHER HQ ON LIST OF TARGETS
YES
ASSIGN SUPPORTING ARM TO TARGET ON LIST OF TARGETS
NO
DID BATTALIONS SUBMIT TAR'S FOR AVIATION SUPPORT ?
NO
YES
ANALYZE/APPROVE AND ANNOTATE ON TAR'S
H-8

H-8

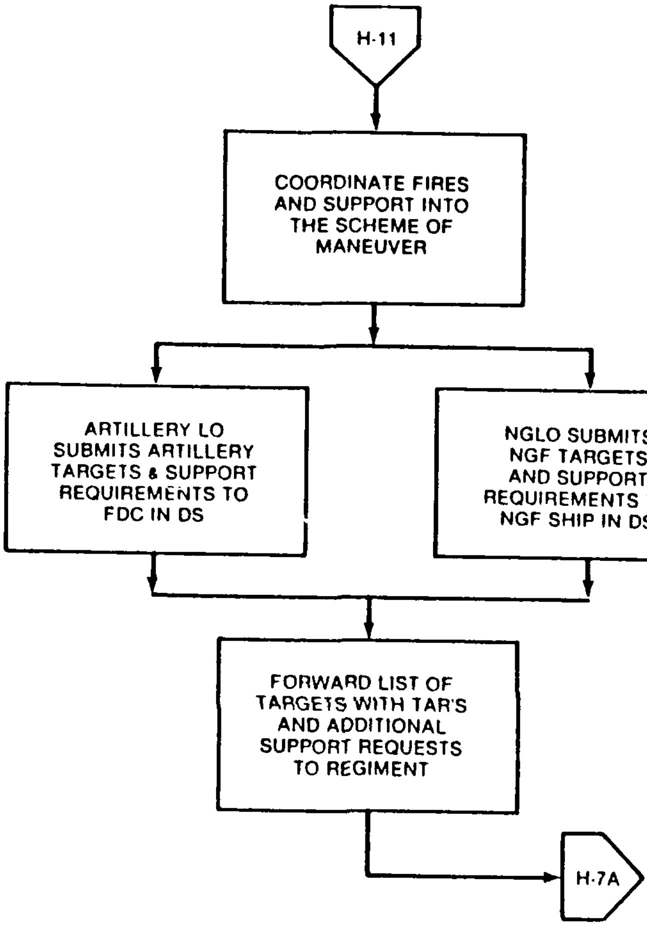

H-8
COORDINATE REGIMENTS' SUPPORTING ARMS WITH BATTALIONS'
ARTILLERY LO SUBMITS ARTILLERY TARGETS & SUPPORT REQUIREMENTS TO DS BATTALION
NGLO SUBMITS NGF TARGETS AND SUPPORT REQUIREMENTS TO GS NGF SHIPS
CONSOLIDATE AND FORWARD LIST OF TARGETS W/TAR'S & REQUESTS FOR ADD'L FIRES TO DIVISION
H-3A


H-9
RECEIVE ORDERS FROM REGIMENT TO INCLUDE AVIATION PRIORITY OF FIRES AND SUPPORT
CONDUCT MISSION ANALYSIS
BATTALION COMMANDER ISSUES PLANNING GUIDANCE
FORMULATE CONCEPT OF OPERATIONS
DEVELOP SCHEME OF MANEUVER
IDENTIFY AND COLLATE TARGETS FOR SCHEDULED & ON-CALL FIRES
RESOLVE DUPLICATIONS
H-10

H-10


H-10
CONDUCT TARGET ANALYSIS AND REQUIREMENTS FOR SUPPORTING ARMS
SELECT BEST SUPPORTING ARM FOR TARGET
IS SUPPORTING ARM ALLOCATED OR ORGANIC TO BATTALION ?
NO
CAN OTHER ARM BE SUBSTITUTED W/O LOSS OF EFFECTIVENESS ?
NO
YES
YES
ASSIGN SUPPORTING ARM TO TARGET ON LIST OF TARGETS
REQUEST SUPPORTING ARM FROM HIGHER HQ ON LIST OF TARGETS
YES
ARE THERE OTHER TARGETS FOR SCHED OR ON-CALL FIRES ?
NO
ARE ANY FIRES OR SUPPORT LISTED FOR AVIATION ?
YES
COMPLETE TACTICAL AIR REQUEST FORM ANNOTATING BATTALION TARGET NUMBER ON FORM
COMPILE ALL AIR REQUEST FORMS AND ATTACH TO LIST OF TARGETS
NO
H-11

H-11

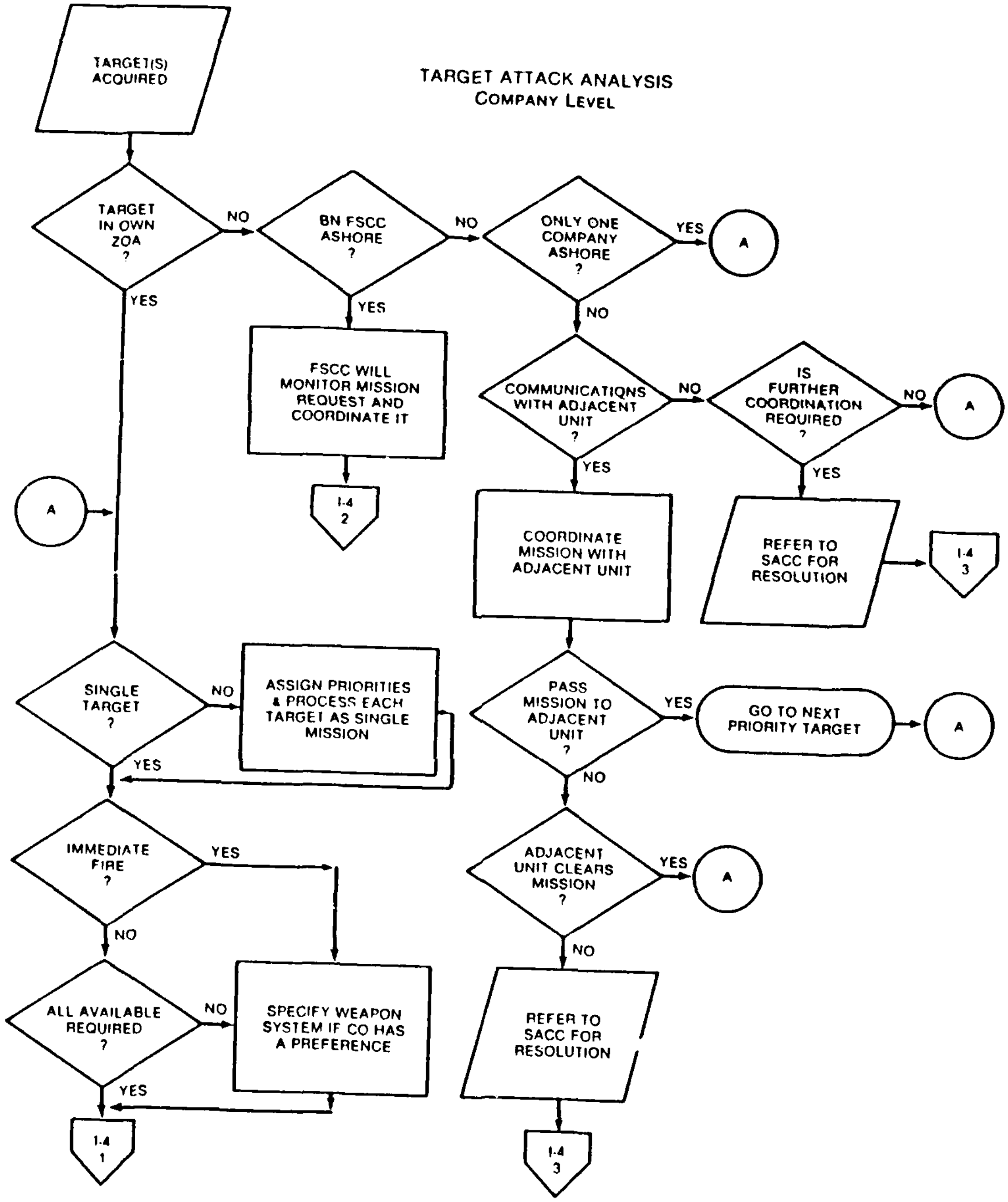

H-11
COORDINATE FIRES AND SUPPORT INTO THE SCHEME OF MANEUVER
ARTILLERY LO SUBMITS ARTILLERY TARGETS & SUPPORT REQUIREMENTS TO FDC IN DS
NGLO SUBMITS NGF TARGETS AND SUPPORT REQUIREMENTS TO NGF SHIP IN DS
FORWARD LIST OF TARGETS WITH TAR'S AND ADDITIONAL SUPPORT REQUESTS TO REGIMENT
H-7A

targets that is disseminated up the chain of command along with any additional requests for fire support.

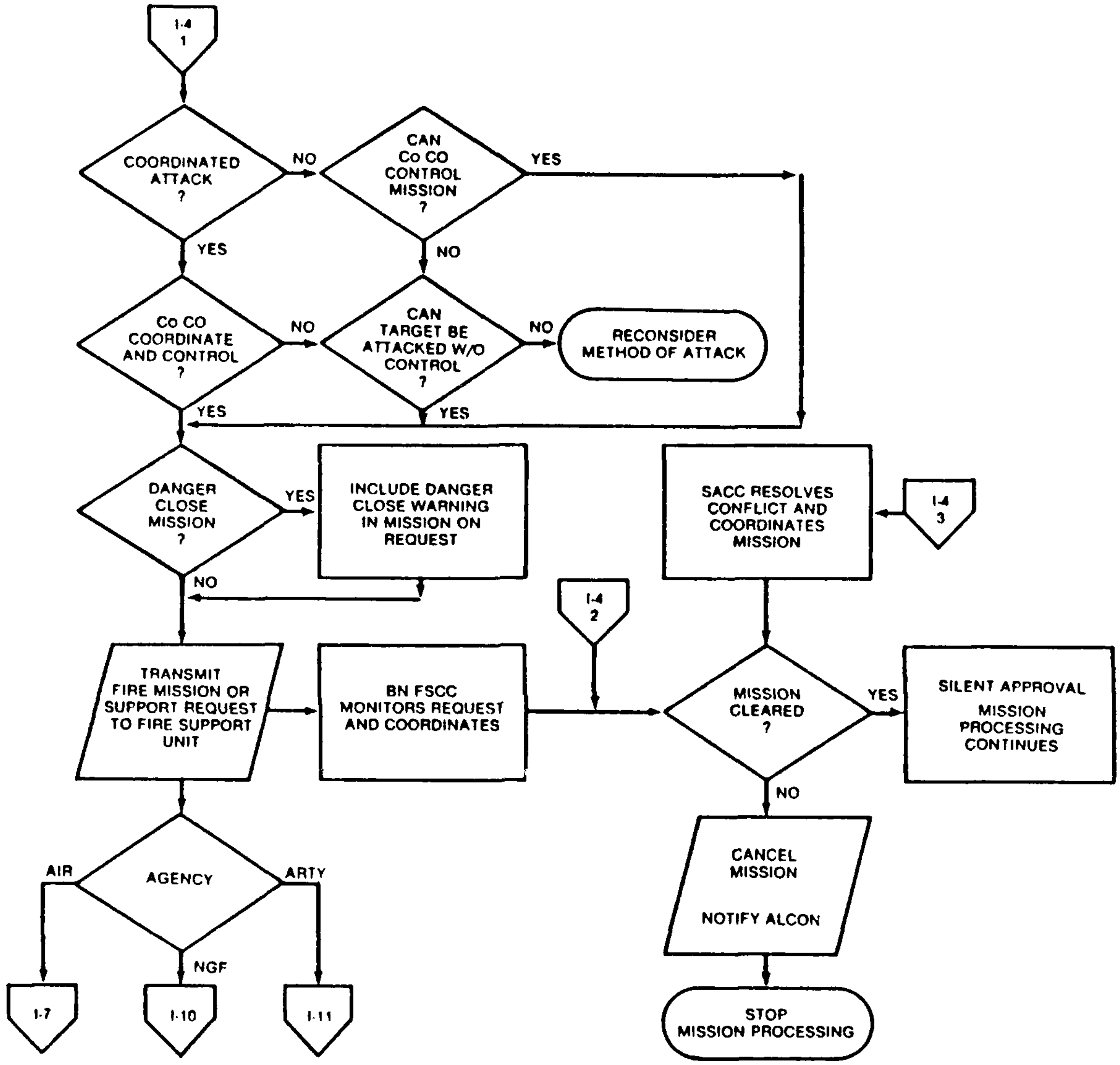
D. FIRE SUPPORT COORDINATION PROCESS

The previous section demonstrated the fire support planning process, this section will demonstrate the fire support coordination process. This series of flow charts is provided by Marine Corps doctrinal publications. [Ref.1: pp. I-3--I-13] Included in the flow charts are the initial target attack analysis, target coordination and safety checks, and the mission processes for coordination of the three types of supporting arms available: close air support, naval gunfire, and field artillery. This section gives a more detailed description of the diverse coordination activities taking place within the fire support system. This section is intended to give an appreciation for the complexity of the process confronting the SAC/FSC.

The following is a synopsis of the events occurring in the fire support coordination process. While the previous section described the formal fire planning process, this section deals more with the "on call" or unscheduled fire missions and how they are processed. (On pages 45-56 below, the page reference from Reference 1 is indicated at the bottom of the page.) Page I-3 begins the process with an infantry company acquiring a target. The company decides whether it can handle the mission alone (A) or whether further coordination is required (I-4.1,2,3). Page I-4

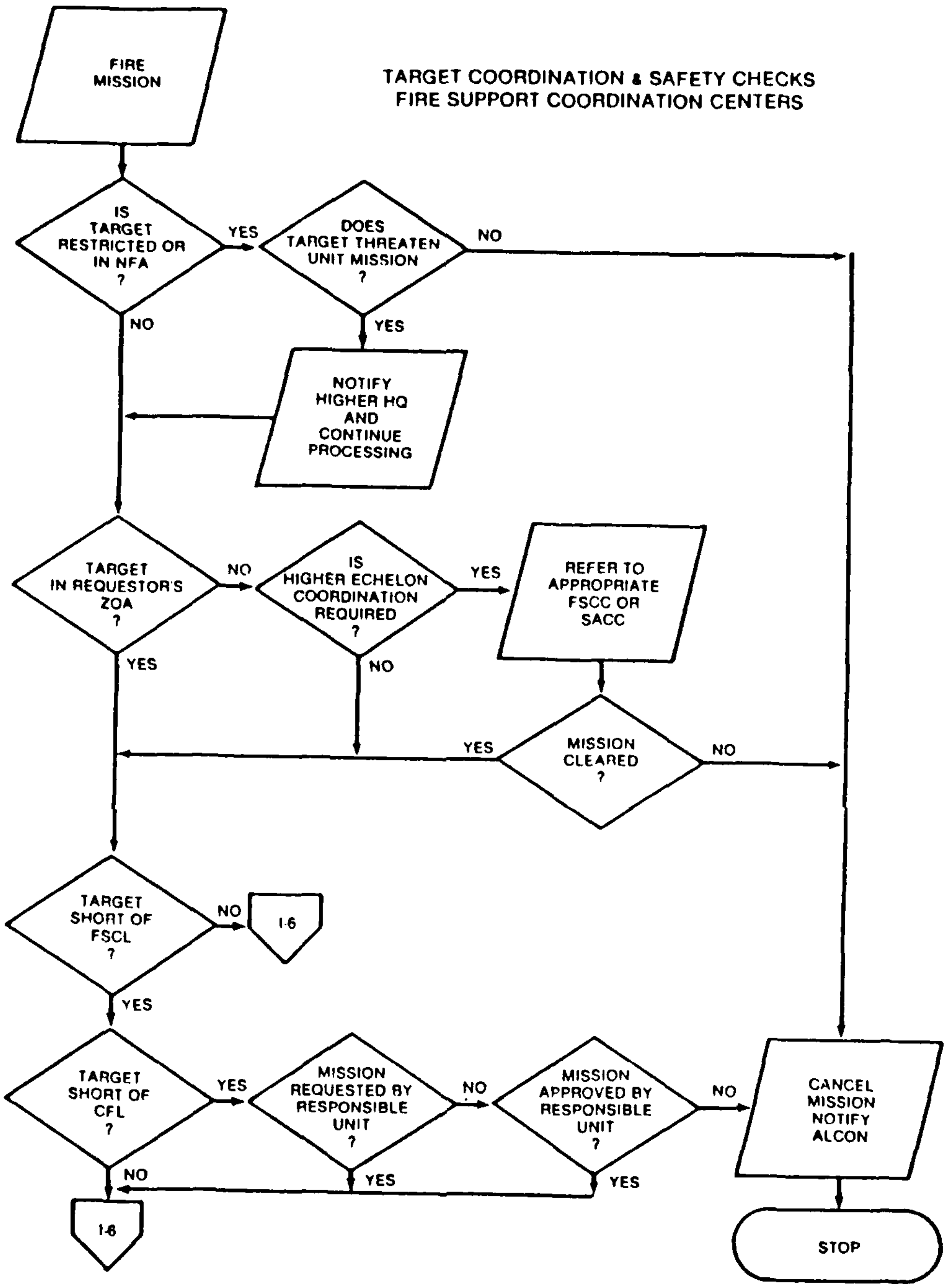

TARGET ATTACK ANALYSIS
COMPANY LEVEL
TARGET(S) ACQUIRED
TARGET IN OWN ZOA ?
NO
YES
BN FSCC ASHORE ?
YES
FSCC WILL MONITOR MISSION REQUEST AND COORDINATE IT
I-4 2
ONLY ONE COMPANY ASHORE ?
A
COMMUNICATIONS WITH ADJACENT UNIT ?
IS FURTHER COORDINATION REQUIRED ?
REFER TO SACC FOR RESOLUTION
I-4 3
COORDINATE MISSION WITH ADJACENT UNIT
PASS MISSION TO ADJACENT UNIT ?
GO TO NEXT PRIORITY TARGET
ADJACENT UNIT CLEARS MISSION ?
SINGLE TARGET ?
ASSIGN PRIORITIES & PROCESS EACH TARGET AS SINGLE MISSION
IMMEDIATE FIRE ?
ALL AVAILABLE REQUIRED ?
SPECIFY WEAPON SYSTEM IF CO HAS A PREFERENCE
I-4 1

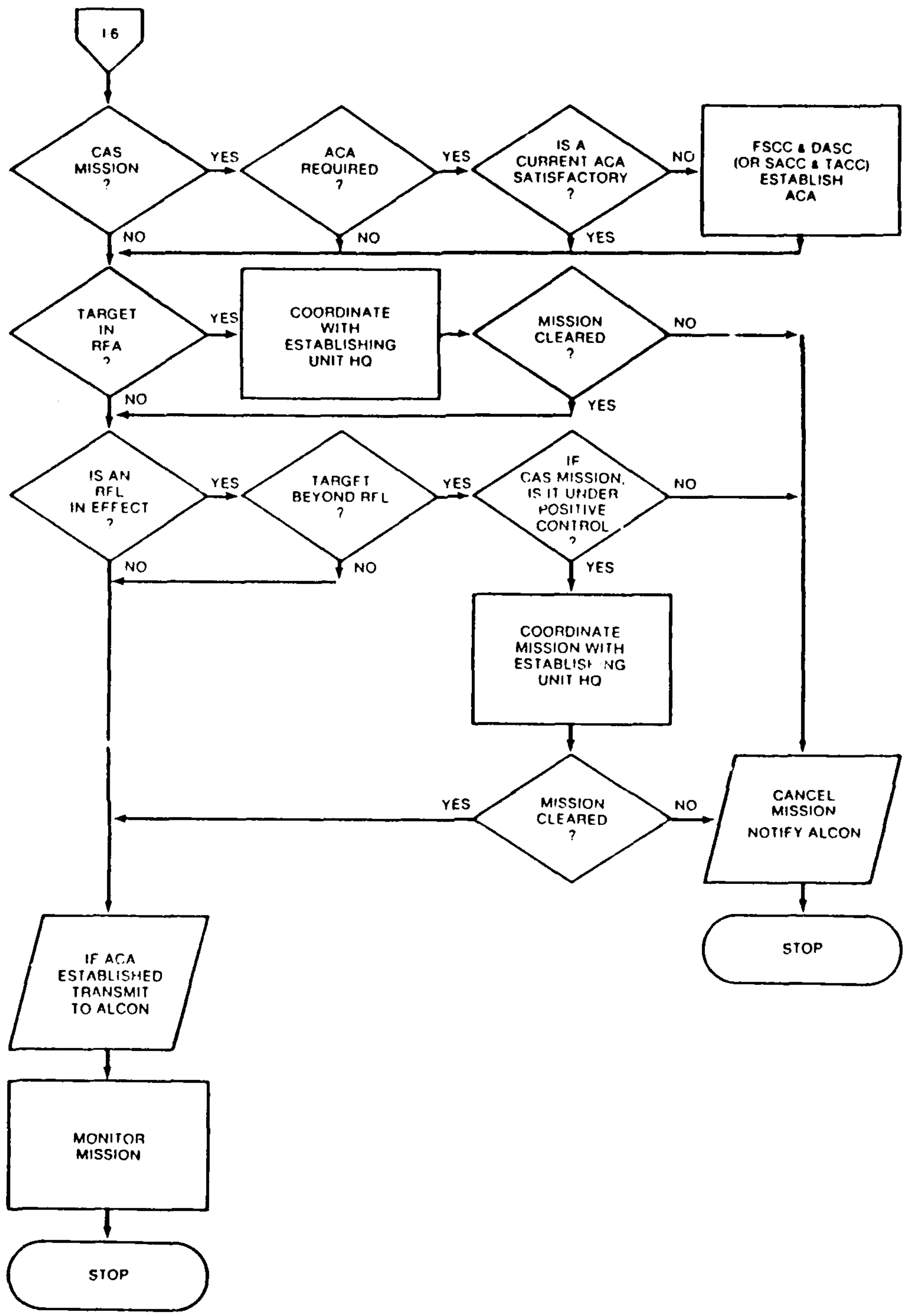
I-3

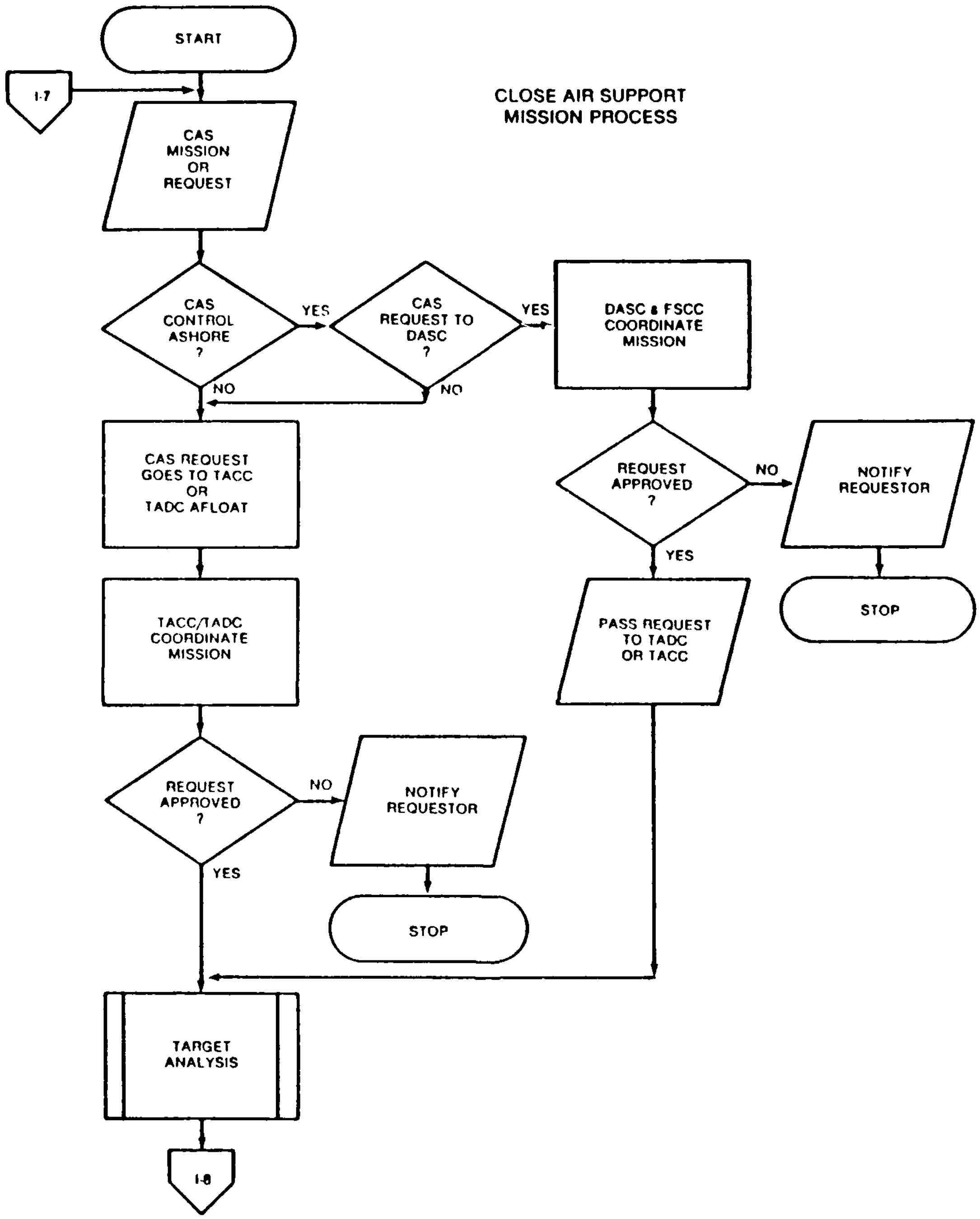

I-4 1
COORDINATED ATTACK ?
NO
CAN Co CO CONTROL MISSION ?
YES
YES
NO
Co CO COORDINATE AND CONTROL ?
NO
CAN TARGET BE ATTACKED W/O CONTROL ?
NO
RECONSIDER METHOD OF ATTACK
YES
YES
DANGER CLOSE MISSION ?
YES
INCLUDE DANGER CLOSE WARNING IN MISSION ON REQUEST
NO
SACC RESOLVES CONFLICT AND COORDINATES MISSION
I-4 3
I-4 2
TRANSMIT FIRE MISSION OR SUPPORT REQUEST TO FIRE SUPPORT UNIT
BN FSCC MONITORS REQUEST AND COORDINATES
MISSION CLEARED ?
YES
SILENT APPROVAL
MISSION PROCESSING CONTINUES
NO
CANCEL MISSION
NOTIFY ALCON
STOP MISSION PROCESSING
AIR
AGENCY
ARTY
NGF
I-7
I-10
I-11

I-4

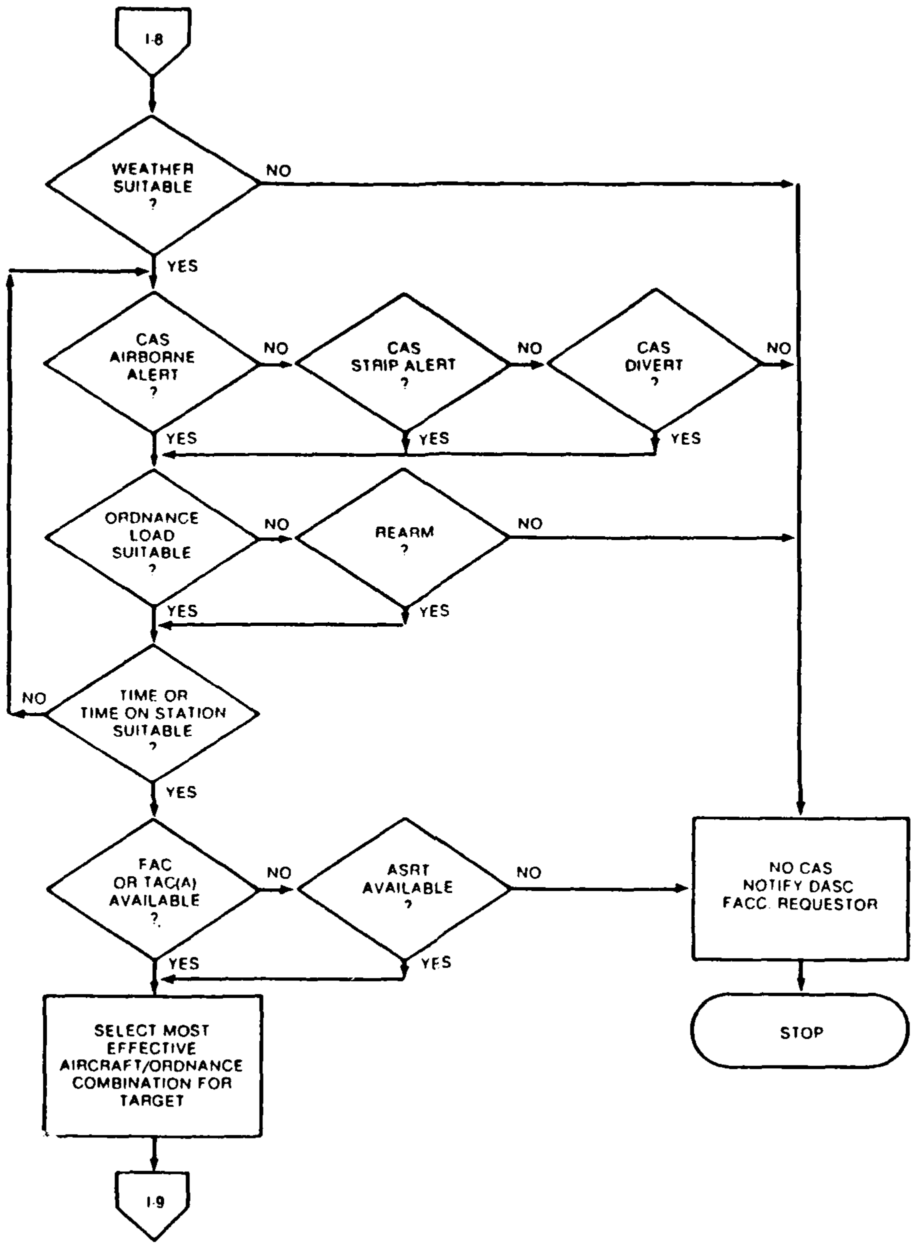
TARGET COORDINATION & SAFETY CHECKS
FIRE SUPPORT COORDINATION CENTERS

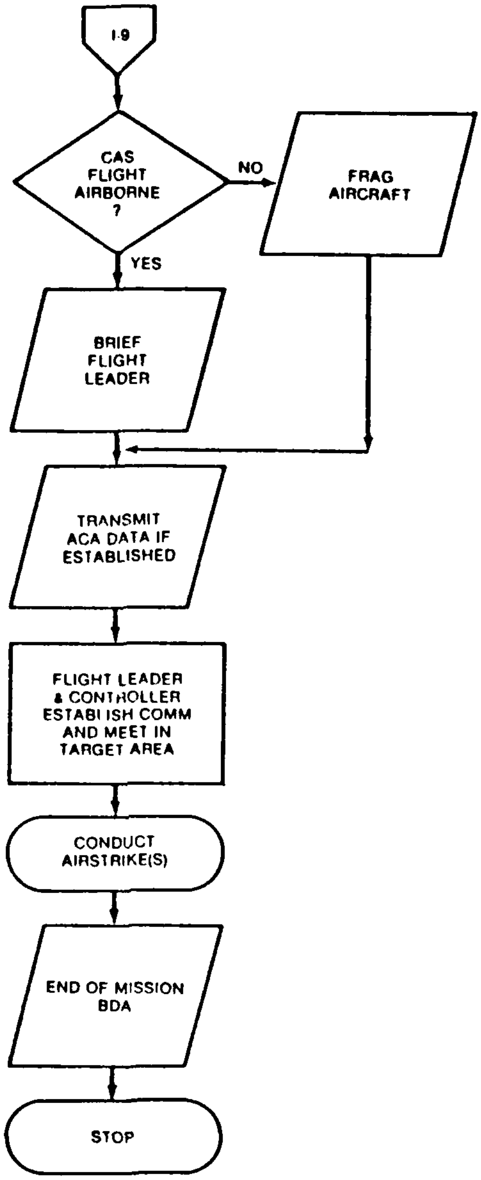



16
CAS MISSION ?
YES
NO
ACA REQUIRED ?
YES
NO
IS A CURRENT ACA SATISFACTORY ?
NO
YES
FSCC & DASC (OR SACC & TACC) ESTABLISH ACA
TARGET IN RFA ?
YES
NO
COORDINATE WITH ESTABLISHING UNIT HQ
MISSION CLEARED ?
NO
YES
IS AN RFL IN EFFECT ?
YES
NO
TARGET BEYOND RFL ?
YES
NO
IF CAS MISSION, IS IT UNDER POSITIVE CONTROL ?
NO
YES
COORDINATE MISSION WITH ESTABLISHING UNIT HQ
MISSION CLEARED ?
YES
NO
CANCEL MISSION
NOTIFY ALCON
STOP
IF ACA ESTABLISHED TRANSMIT TO ALCON
MONITOR MISSION
STOP


START
I-7
CAS
MISSION
OR
REQUEST
CLOSE AIR SUPPORT
MISSION PROCESS
CAS
CONTROL
ASHORE
?
YES
CAS
REQUEST TO
DASC
?
YES
DASC & FSCC
COORDINATE
MISSION
NO
NO
CAS REQUEST
GOES TO TACC
OR
TADC AFLOAT
REQUEST
APPROVED
?
NO
NOTIFY
REQUESTOR
YES
STOP
TACC/TADC
COORDINATE
MISSION
PASS REQUEST
TO TADC
OR TACC
REQUEST
APPROVED
?
NO
NOTIFY
REQUESTOR
YES
STOP
TARGET
ANALYSIS
I-8

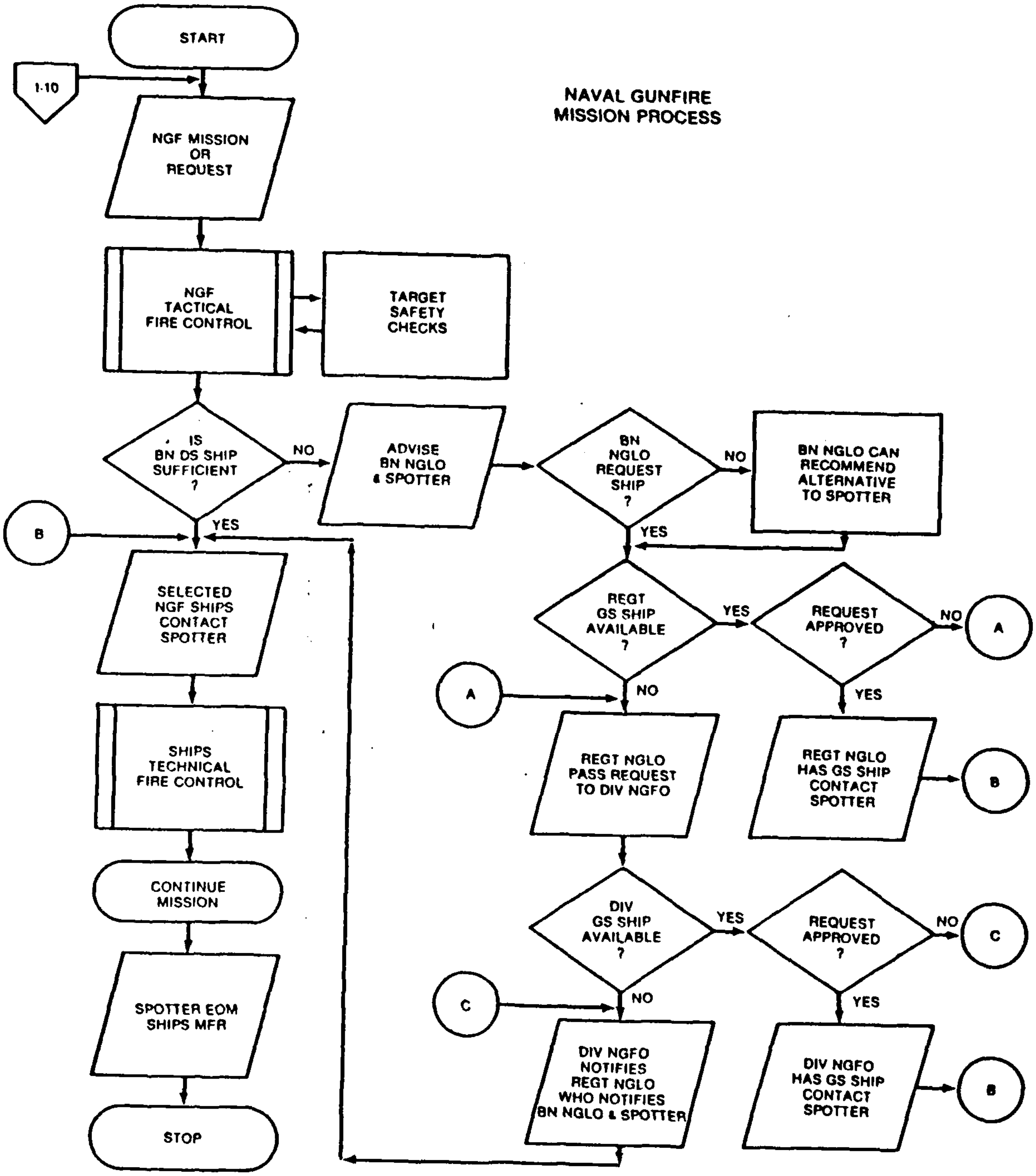
I-7

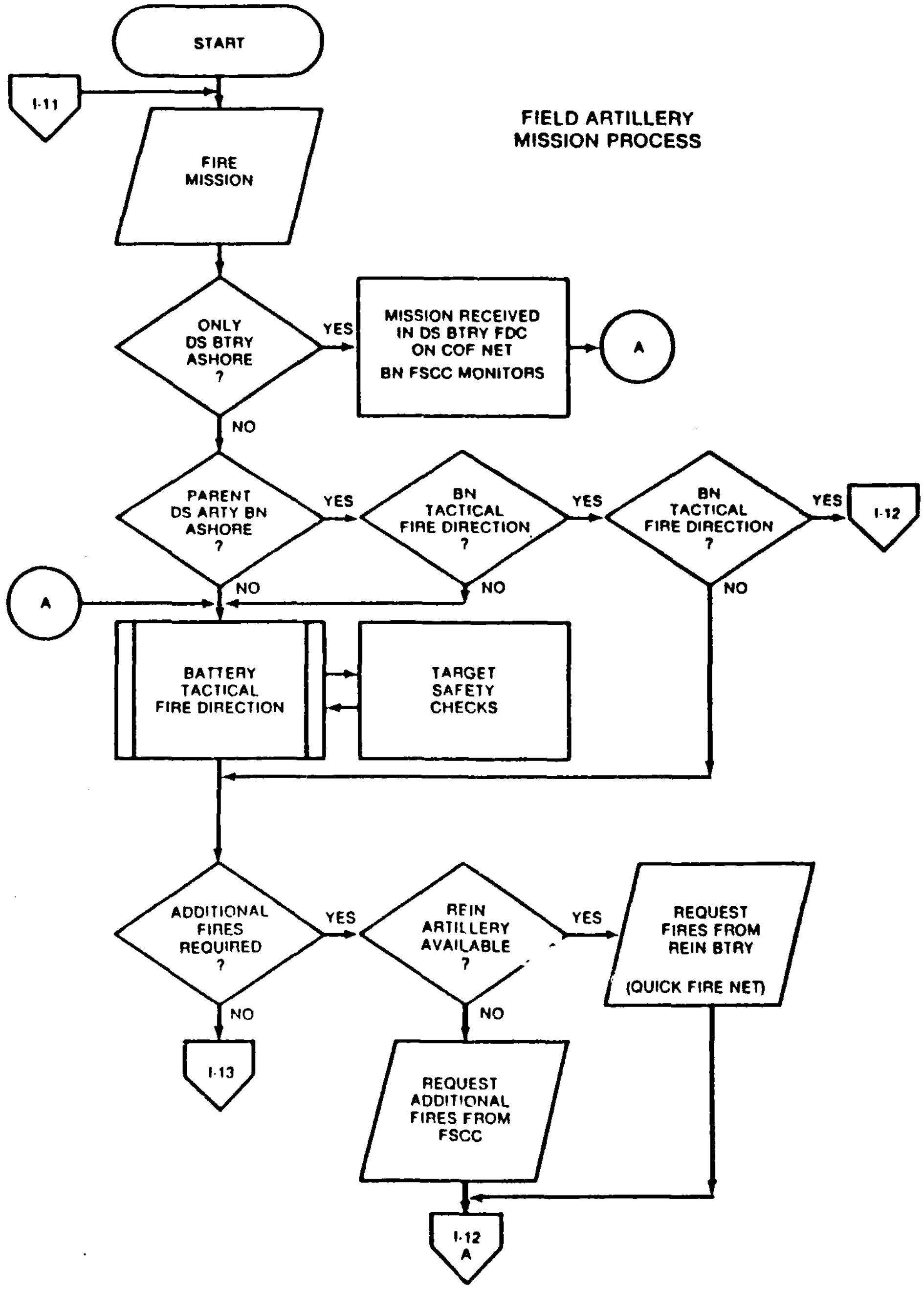

I-8
WEATHER SUITABLE ?
NO
YES
CAS AIRBORNE ALERT ?
NO
CAS STRIP ALERT ?
NO
CAS DIVERT ?
NO
YES
YES
YES
ORDNANCE LOAD SUITABLE ?
NO
REARM ?
NO
YES
YES
NO
TIME OR TIME ON STATION SUITABLE ?
YES
FAC OR TAC(A) AVAILABLE ?
NO
ASRT AVAILABLE ?
NO
NO CAS NOTIFY DASC FACC. REQUESTOR
YES
YES
STOP
SELECT MOST EFFECTIVE AIRCRAFT/ORDNANCE COMBINATION FOR TARGET
I-9

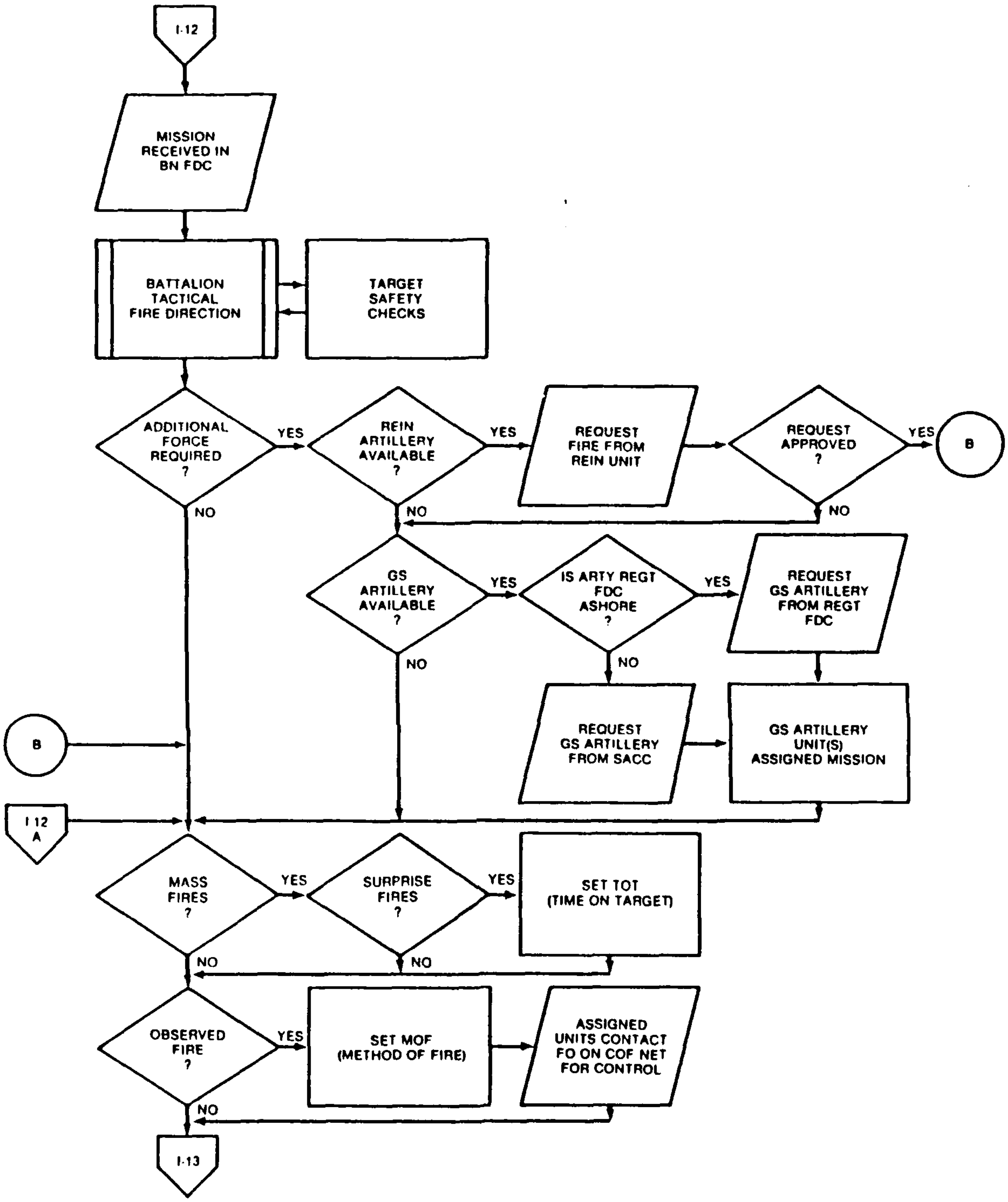

I-9
CAS FLIGHT AIRBORNE ?
NO
YES
FRAG AIRCRAFT
BRIEF FLIGHT LEADER
TRANSMIT ACA DATA IF ESTABLISHED
FLIGHT LEADER & CONTROLLER ESTABLISH COMM AND MEET IN TARGET AREA
CONDUCT AIRSTRIKE(S)
END OF MISSION BDA
STOP

I-9

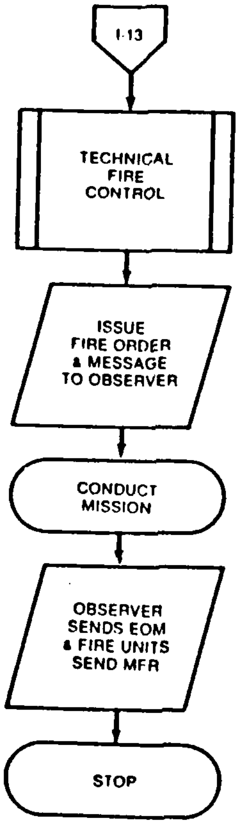
NAVAL GUNFIRE
MISSION PROCESS




START
I-11
FIELD ARTILLERY
MISSION PROCESS
FIRE
MISSION
ONLY
DS BTRY
ASHORE
?
YES
MISSION RECEIVED
IN DS BTRY FDC
ON COF NET
BN FSCC MONITORS
A
NO
PARENT
DS ARTY BN
ASHORE
?
YES
BN
TACTICAL
FIRE DIRECTION
?
YES
BN
TACTICAL
FIRE DIRECTION
?
YES
I-12
A
NO
NO
NO
BATTERY
TACTICAL
FIRE DIRECTION
TARGET
SAFETY
CHECKS
ADDITIONAL
FIRES
REQUIRED
?
YES
REIN
ARTILLERY
AVAILABLE
?
YES
REQUEST
FIRES FROM
REIN BTRY
(QUICK FIRE NET)
NO
NO
I-13
REQUEST
ADDITIONAL
FIRES FROM
FSCC
I-12
A


I-12
MISSION RECEIVED IN BN FDC
BATTALION TACTICAL FIRE DIRECTION
TARGET SAFETY CHECKS
ADDITIONAL FORCE REQUIRED ?
YES
NO
REIN ARTILLERY AVAILABLE ?
YES
NO
REQUEST FIRE FROM REIN UNIT
REQUEST APPROVED ?
YES
NO
B
GS ARTILLERY AVAILABLE ?
YES
NO
IS ARTY REGT FDC ASHORE ?
YES
NO
REQUEST GS ARTILLERY FROM REGT FDC
REQUEST GS ARTILLERY FROM SACC
GS ARTILLERY UNIT(S) ASSIGNED MISSION
B
I 12 A
MASS FIRES ?
YES
NO
SURPRISE FIRES ?
YES
NO
SET TOT (TIME ON TARGET)
OBSERVED FIRE ?
YES
NO
SET MOF (METHOD OF FIRE)
ASSIGNED UNITS CONTACT FO ON COF NET FOR CONTROL
I-13

I-12


I-13
TECHNICAL
FIRE
CONTROL
ISSUE
FIRE ORDER
& MESSAGE
TO OBSERVER
CONDUCT
MISSION
OBSERVER
SENDS EOM
& FIRE UNITS
SEND MFR
STOP

I-13

continues with the mission processing ard coordination. This results in either a canceled mission or a transmitted fire support request to supporting arms agency (I-7,I-10,I-11). Pages I-5 to I-6 are where the target coordination and safety checks are accomplished. The FSCC/SACC are monitoring all missions. This procedure is performed on every mission and provides for troop safety. This procedure results in the mission either being cleared safe or stopped. Pages I-7 to I-9 depict the close air support mission process. This shows the steps the aviation community goes through in order to conduct an airstrike. Page I-10 shows the process the naval gunfire community goes through in directing a mission. Pages I-11 to I-13 illustrate the process that the field artillery units go through before they fire upon a target.

IV. COORDINATION PRINCIPLES APPLICATION

A. BACKGROUND

The entire structure described in Chapters I and II cannot operate efficiently without a coordinated effort. How is this achieved and who does the coordinating? This is the scope of what Chapter IV will present. Before beginning to describe who is involved in the coordination process, one must first be knowledgeable about coordinating mechanisms and their existence in the system. Henry Mintzberg, defines six basic coordinating mechanisms that describe the fundamental ways in which organizations coordinate their work. Some of these are informal methods of coordination while the others involve some type of standardization to ensure that the work is coordinated.

B. COORDINATION MECHANISMS

1. Mutual Adjustment

This is an informal method of coordination. This method achieves coordination through the simple process of informal communication. The people who do the work interact with each other to ensure coordination occurs. Mutual adjustment is prevalent in the simplest and the most complex of organizations. In simplistic organizations it is used because it is an obvious way to communicate. In complex organizations it is used because often it is the only

reliable means of accomplishing coordination under adverse conditions. This method is analogous to two men in a canoe coordinating their effort through simple communication. [Ref. 8:p. 279] It should be noted that mutual adjustment can be formal in large complex organizations. An example of this would be a task force.

2. Direct Supervision

This is a mechanism of coordination that involves one person giving orders to others. This usually arises out of a situation where a number of individuals must work together and mutual adjustment is not considered an effective mechanism of coordination. This is the situation where a leader or commander is required to initiate the coordination. This method would be analogous to a larger, eight man canoe where simple communication would not accomplish the coordination necessary to propel the boat swiftly. A coxswain would be added to directly supervise and coordinate the action of the men. [Ref. 8:p. 279]

3. Standardization of Work Processes

This is a mechanism that ensures coordination through the detailed specification of the work processes. The work of different people in the organization is programmed to facilitate coordination. In a military organization this is similar to having a detailed Standard Operating Procedure (SOP) that is strictly adhered to. Some examples of this are the procedures followed in the

assembly/disassembly of a rifle or some specific maintenance procedure. [Ref. 8:p. 279]

4. Standardization of Outputs

This mechanism of coordination specifies what the output or results of a process are supposed to represent. In this manner the interfaces between individuals is predetermined. Each successive link in the process knows what the output of the other links will be and this achieves coordination. [Ref. 8:p. 279] An example of this type of output is shown in Figure 7. This is a form used for target analyses which ensures a logical and orderly examination of all factors to determine the most effective means of attacking a target. This form is extractd from Marine Corps doctrinal publications. [Ref. 5:pp. AD-1--AD-2]

5. Standardization of Skills

This is the mechanism of coordination where the worker is standardized not the output or the work process. This can be considered a looser way to achieve coordination. The workers skills or knowledge are often standardized external to the organization in which they work. This standardization would typically be accomplished in a military service training school. The individual is taught a body of knowledge and a set of skills which are subsequently applied to the work. Coordination is then achieved by virtue of various operators having learned what

TARGET ANALYSIS

1. SITUATION AND COURSE OF ACTION

a. Situation of Opposing Forces

(1) Enemy Situation. Include information that will aid in target analysis.

(2) Friendly Situation. Include information that will aid in attacking the target.

b. Target Characteristics

(1) Target Description. Include type (personnel, materiel, terrain features), number of personnel, quantity of materiel, and activity.

(2) Vulnerability. Include type and amount of cover, type of materiel, type of construction, mobility, and density of personnel and materiel.

(3) Physical Location and Altitude. Include grid reference and altitude of target, location with respect to supported unit and terrain features, and proximity to friendly troops.

(4) Accuracy of Location. Give estimated accuracy of target location.

(5) Size and Shape of Target Area. Give the dimensions and shape of the target area and distribution of personnel and materiel within the area.

(6) Terrain and Weather. Include brief analysis of weather and terrain in the target area; include any terrain features affecting the means and methods of attack.

c. Target Capabilities. Discuss the capabilities of the target as they affect the accomplishment of the mission of the supported unit; if a terrain feature(s), show how it affects enemy capabilities.

d. Other Factors. List and discuss any or all of the following factors and any additional ones that will affect the choice of firepower, delivery means, and method of attack:

(1) Urgency of Attack. Usually determined by the type of target (static or fleeting) and its capabilities.

(2) Enemy Countermeasures. State ability of the enemy to minimize the effects of firepower; consider capabilities of the enemy to prevent effective delivery and to bring countermeasures against delivery means after attack.

Figure 7. Example of Standardized Output (Target Analysis)

(3) Enemy Discipline and Morale. State factors which will aid in determining the amount of firepower required to neutralize personnel targets.

(4) Creation of Obstacles. Discuss any considerations concerning desirability or undesirability of creating obstacles by attacking the target.

(5) Civilian Casualties. Show approximate number of civilians in the target area and the estimated effect of causing excessive casualties.

(6) Surprise. Discuss any particular methods desired to obtain surprise, including least expected time of attack, means of delivery, and restrictions on registration.

e. Means of Attack. Note all available types of firepower and required amounts with which it would be practical to attack the target; show most practicable delivery means in each case.

2. ANALYSIS OF MEANS OF ATTACK

Discuss the effect of each means of attack on the target characteristics (par. 1b), target capabilities (par. 1c), and other factors (par. 1d). For each means of attack, include:

a. Location of center of impact which will obtain greatest effect; include optimum height of burst for nuclear weapons.

b. Effect of available supply rate.

c. Estimate of enemy casualties and materiel damage.

d. Estimate of civilian casualties.

e. Estimate of obstacles created.

f. Precautions required for friendly troops.

Note: The analysis of each means of attack may be shown in an annex.

3. COMPARISON OF MEANS OF ATTACK

Summarize the outstanding advantages and disadvantages of each means of attack and determine which offers the greatest promise of success.

4. DECISION OR RECOMMENDATION

a. Type and amount of firepower and delivery means.

b. Unit(s) to fire.

c. Grid reference and altitude of desired center of impact; height of burst when applicable.

d. Time of attack.

e. Safety precautions, special coordination, and warnings required.

f. Method for determining poststrike analysis.

Figure 7. (Continued)

to expect of each other. They do not necessarily need to communicate to achieve coordination they just know how each other will perform. [Ref. 8:p. 280]

6. Standardization of Norms

This method of coordination is a result of the individuals in an organization sharing a common set of beliefs. For example, all the individuals in the fire support system share the same belief of supporting the maneuver element and rendering its fire support assets upon the enemy. Coordination is achieved because they all know they must work together to achieve this shared goal. [Ref. 8:p. 280]

These six coordinating mechanisms will be used to highlight how the fire support process reaches coordination. As Henry Mintzberg states, "These coordinating mechanisms are the basic means that link together the divided labor of the organization. They serve as the most basic elements of structure--the glue that holds the organization together." [Ref. 8:p. 280]

C. LIAISON DEVICES

Mutual adjustment may often occur naturally in small work units but to ensure that mutual adjustment occurs, a formal structure is required. These formal structures are called liaison devices and their purpose is to stimulate the occurrence of mutual adjustment between units. There are

four types of liaison devices with the intended purpose of facilitating coordination.

1. Liaison Positions

These are job positions created to coordinate the work of a number of units directly. This position is not necessarily a formal one. It is, however, given enough latitude to influence the situation so that coordination is reached. They are given the capability to coordinate without passing through any additional vertical or managerial channels. They normally do not carry much formal authority over the units they coordinate with and must rely upon their powers of persuasion and negotiation to foster coordination between two units. [Ref. 8:p. 287]

2. Task Forces and Standing Committees

These are institutionalized forms of meetings which bring together members of different units. Task forces are an effective horizontal linkage device for dealing with temporary issues. The task force brings together experts/representatives from various fields to deal with some temporary issue and come up with a recommended course of action. After this phase was accomplished, a standing committee would be formed to implement and oversee the proposed strategy. Task forces are temporary devices while standing committees are a more permanent liaison structure. [Ref. 8:p. 287]

3. Integrating Managers

These are essentially liaison positions but with formal authority over some aspects of the units they coordinate between. An example would be control of resources. This device is stronger than the previous two because the integrating manager does not have to rely as much on his powers of negotiation and persuasion to get things accomplished. The integrating manager is given enough formal authority over the units that he can facilitate coordination. [Ref. 8:p. 280]

4. Matrix Structure

This device is often used when the environment that the organization operates within is complex and uncertain. There is often environmental pressure placed upon two or more critical outputs (i.e., plans and coordination). This double pressure usually results in a dual authority structure being formed. The vertical and horizontal lines of authority must be given equal recognition. A dual authority structure is thereby created so the balance of power between them is equal. A drawback to the matrix structure is that people often end up reporting to two bosses which can reduce the ability to have unity of effort. [Ref. 8:p. 280]

D. APPLICATION TO FIRE SUPPORT SYSTEM

Now that the various coordination mechanisms and liaison devices used in organizations have been introduced, the task

is to apply them to the fire support architecture. The fire support architecture that was described back in Figure 6 shows that there are numerous vertical and horizontal links. Coordination is most often needed in organizations that are horizontally specialized, since specialization impedes natural coordination. Specifically, each of the processes (Weapons, Sensing, Processing, Weaponeering) are primarily concerned with the execution of their duties and accomplishment of their mission. They are not necessarily concerned with the status of the other processes. This justifies the need for a more formal structure of coordination to ensure the flow of information. The functional grouping of the processes depicted in Figure 6 illustrates that there is much horizontal specialization. Additionally, coordination is needed in organizations that are complex and where there is much interdependence among the units. The fire support system certainly fits both these criteria. [Ref. 8:p. 289]

1. Vertical Links

Throughout the various levels of the architecture there are a number of vertical links. These vertical links depict the existence of direct supervision. This is the situation where the leader is required to initiate the coordination. The leader has formal authority over those he is linked to and exercises his power to ensure that the vertical information flow and coordination are transpiring.

The vertical control and coordination is extensive throughout the architecture and requires little explanation since it is prevalent throughout most organizations in our society. It is relatively simple to understand that if your boss initiates the coordination you will coordinate. The difficult coordination concepts to comprehend are the ones dealing with the horizontal links.

2. <u>Horizontal Links</u>

Levels three and four are where the predominance of the various horizontal links occur and will serve to highlight the coordination mechanisms and liaison devices that operate throughout.

a. Level Three

Figure 8 depicts the interunit links among the four major processes of the architecture. For clarification, visualize that there is a big box surrounding this figure that represents the SACC/FSCC acting as the unit bringing this all together. As shown in the diagram there are various inputs and outputs among the processes confirming the existence of interdependence. The beginning of the fire support cycle is the sensing process. The inputs tc sensing are environmental factors (weather and topography) and a mission tasking that delineates what it is supposed to sense. The sensing function is systematic and once an assignment has been directed the area is sensed and the raw data acquired from the process is passed along to

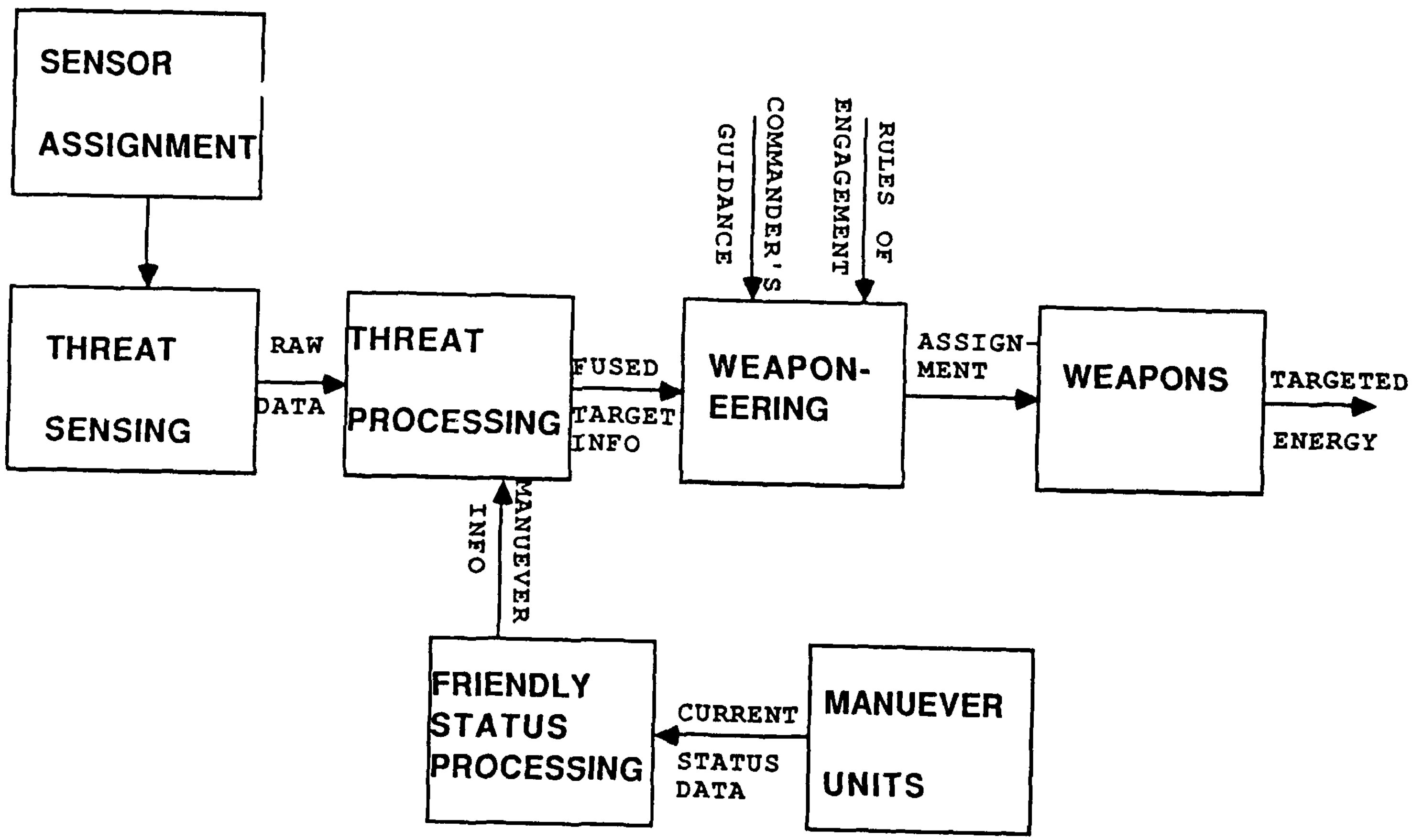


Figure 8. Level Three Interunit Links

the analysis function. The analysis function takes additional input from the friendly maneuver units to integrate with the data it received from the sensing function. It does this to ensure that it has a complete picture of the situation so that the analysis and subsequent recommendations are accurate. The output of the analysis function is fused target information that is germane to the data required by the weaponeering function. In addition to the target information, the weaponeering function also must take into consideration the Commander's guidance and the Rules of Engagement (ROE) that are relevant to the operation. Commander's guidance would include such items as:

- Which are the priority targets.
- What are the desired effects against specific types/ classes of targets.
- What is the scheme of maneuver.
- Any safety restraints to be placed upon supporting arms
- What are his future intentions.

Rules of Engagement are permissive or restrictive measures that give guidance concerning the extent of action that may be taken against an enemy. The eventual output of the weaponeering function is a specific weapon assignment that is conveyed to the appropriate weapons unit. The output of the weapons function is some type of targeted energy that is focused towards the enemy. Keep in mind that this entire

process is not as elementary as the diagram may depict. There is much more interaction transpiring between the various elements in the cycle (i.e., reports, updates, and countless other communications). The limited inputs/outputs shown, illustrate the major purpose of each step in the cycle.

Coordination at this level is mainly accomplished through standardization. It is effected through Standardization of Work Processes and Outputs. In actuality, coordination at this level is attained automatically by virtue of standards that predetermine what each process will do. [Ref. 8:p. 279] Each of the processes have evolved their procedures to the point where they have developed Standard Operating Procedures (SOP). These SOP's guide them in the performance of their functions and delineate what form their output will be in, who it should go to, and how it should be disseminated. A disadvantage to the standardization of this level is the amount of variety that can enter the system. The work processes and outputs can be standardized but you cannot control what the enemy does or even on occasions what your own forces do. This means that no matter how much you prepare, something new will effect a change to the standardization.

b. Level Four

Figure 9 represents the major functions that are being executed and the interunit links that occur between them. At each stage in the cycle the primary input and output are depicted. This level represents the detailed functions that cause the fire support system to operate efficiently. As discussed in level three, level four also has interdependence among its assorted functions. The beginning of the level four cycle is the Reconnaissance and Surveillance function. The outcome of this function is the infusion of raw data that will be used to develop the targeting solution. The next step in the cycle is the Information Fusion function. Here, the raw data received is blended and combined to form a useful target information product. Based on some set models the output of this function is Indications and Warnings. These indications and warnings may be evidence concerning specific aspects of the area of operations or evidence concerning potential enemy actions [Ref. 5:p. 12-1]. The next step is the analysis phase. Here, the evidence received as input is analyzed with the goal of producing target intelligence. The target intelligence portrays and locates the components of a target or target complex and indicates its vulnerability and relative importance [Ref. 5:p. 12-1]. Once the target intelligence is formulated it next goes through a dissemination process. Here the target intelligence is

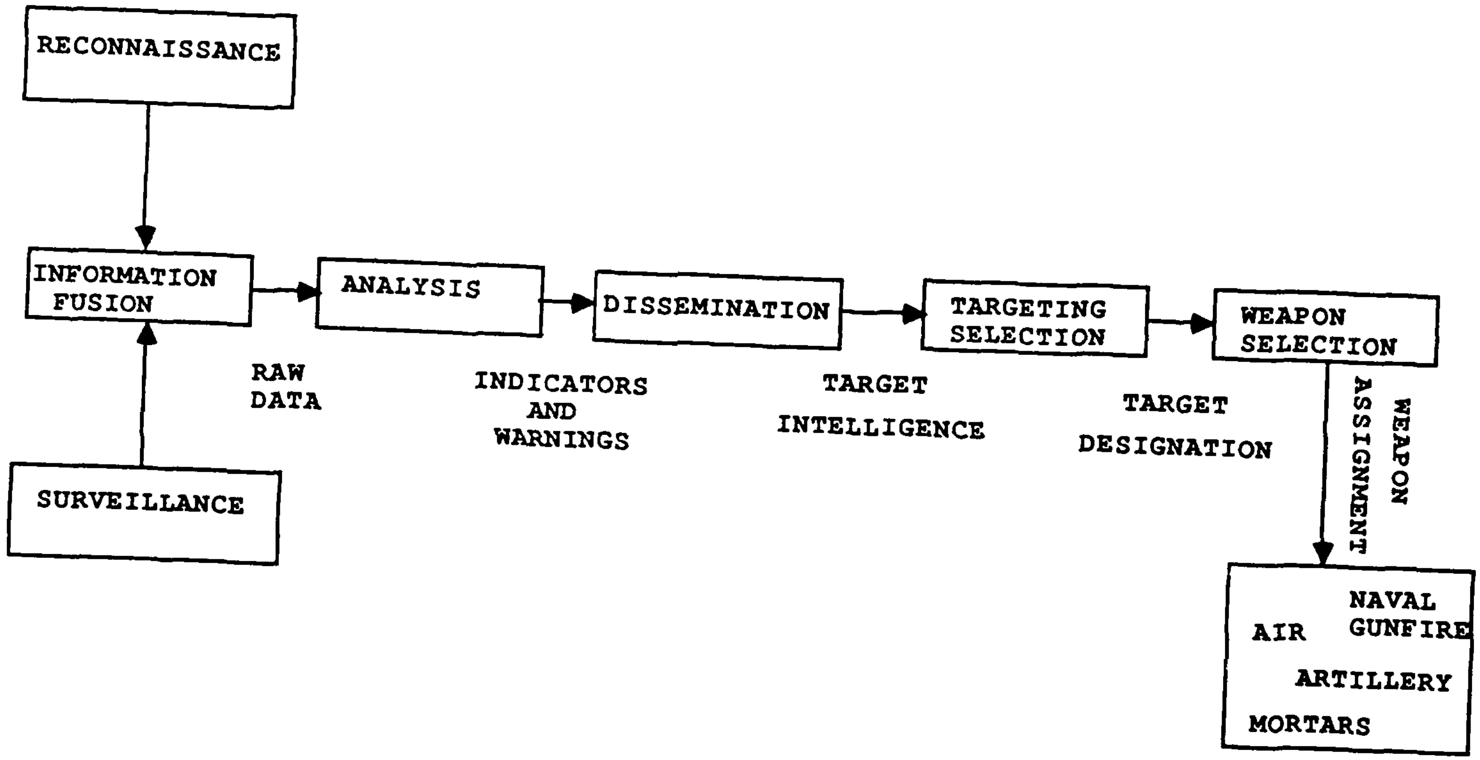


Figure 9. Level Four Interunit Links

matched to the organizational framework and distributed to the appropriate agency for action. The target information identified for the fire support system is next routed to the targeting selection function. This step is where the decision on whether or not the target should be attacked is determined. The result of this function is a target designation number that is used to classify the target. From this point the cycle progresses into the weapons selection phase. This is the stage where the target is matched against the available weapons systems and the optimum weapon is selected to engage the target. Once a weapon system has been assigned that specific weapon community (mortars, air, naval gunfire, artillery) carry out their assigned tasks and attack the target.

Coordination at this level follows along lines similar to level three. Once again much of the coordination is accomplished through standardization. The interdependence among the stages in the level four cycle requires that much of the work processes be standardized. The standard work processes allow the personnel to perform productively and develops a standard output format that can they be passed on to the next stage. Each link in the cycle knows what the format of the output from the previous link will be in. Realize though, that there is going to be variety to the content of the output. The goal of the

standardization at this level is to handle the incoming variety, and information through a coordinated effort.

c. Coordination Unit Level

This is the level where the entire system comes together. This is the level that must coordinate the operations of all the other levels. This unit is representative of a SACC/FSCC. As described in Chapter II, there are numerous representatives from the supporting arms and intelligence communities assigned to the SACC/FSCC. The majority of the personnel assigned to the SACC/FSCC have limited authority over the agencies they represent. They are sent to the unit in a liaison position to bridge the gap between their agency and the SACC/FSCC. Their main purpose is to facilitate coordination. The SAC/FSC themselves are integrating managers. They are essentially liaison personnel with some formal authority over those with whom they coordinate. [Ref. 8:p. 288] They do not have direct authority over the units they link with but they do have responsibility for some of their outputs (i.e., plans and coordination of supporting fires). The SAC/FSC, acting as an integrating manager, must use mutual adjustment and his powers of persuasion to effect coordination. Remember from Chapter I that the SAC is responsible to the CATF for coordinating the delivery of all supporting fires. To accomplish this he must integrate and coordinate the efforts

of the liaison officers and in doing so uses the stronger coordination mechanism of mutual adjustment.

d. Additional Coordination Assistance

There are two other mechanisms of coordination that are pervasive throughout the system and facilitate the coordination. These are the Standardization of Norms and the Standardization of Skills. Since this system is a military organization both these mechanisms contribute to coordination.

Standardization of skills is achieved through professional military schools. For example, the intelligence analyst is trained at a military intelligence school. The military specialty designation that classifies him denotes the special skills he has. This coordination mechanism is prevalent throughout the system since all military personnel are trained at some type of occupational school. This mechanism attains coordination because individuals know what to expect of each other.

Another coordination mechanism that permeates the entire structure is the Standardization of Norms. The implementation of this coordination mechanism is similar to that of the Standardization of Skills. However, this mechanism is not a specific skill training but rather overall military training. This indoctrination training is accomplished during the initial training cycle (Bootcamp). This is where the individual is introduced to the common

beliefs and principles of the organization. Even across different service boundaries there are similar norms. Since each member of the fire support system is a trained military person one would expect that they share common beliefs. This mechanism fosters coordination because each member realizes they must work together to coordinate the delivery of fire support.

V. ALTERNATIVE CASE

A. BACKGROUND

The previous chapters have provided a description of the fire support coordination process. They have defined personnel positions and duties, shown the underlying processes involved in the architecture, and they have identified the numerous horizontal and vertical coordination links contained in the architecture. These links have been further analyzed to show the coordination mechanisms and liaison devices that are prevalent in the system.

The SACC/FSCC face a formidable challenge in the complex environment of the modern day battlefield. Within the last ten years the Marine Corps has gone through several substantial organizational changes. Some of these have affected the fire support system. One of these is the major restructuring of the artillery regiments. They have changed their organizational structure primarily due to the introduction of the new 155mm weapon system. Additionally, infantry battalions have been restructured three times to optimize warfighting capabilities. Recently, the concept of an amphibious task force attacking from "over the horizon" has become an adopted tactic which is undergoing testing. This concept has introduced many new systems and problems for the fire support structure to deal with. Further, in

today's marketplace, there are decision aids and expert systems available that could improve the capabilities of the system. However, with all these changes occurring, the system of integrating and coordinating fires has remained unchanged since World War II and the Korean War. The status quo has characterized fire support coordination. Technological advances in recent years have created a more powerful fire support capability. Today's battlefields are becoming more and more complex because of the influx of advanced electronic systems. The number of sensors that provide more timely and accurate information is increasing. Also enemy forces are becoming more sophisticated. This improved electronic technology combined with a more sophisticated enemy has increased the amount of information available to the SACC/FSCC. [Ref. 12:p. 34]

B. ALTERNATIVE SYSTEM DEVELOPMENT

Given the technological advancements in military systems and the increased complexity of the modern battlefield, the next generation of fire support coordination is needed. The previous chapters have described the organization, concepts, and processes comprising the current fire support coordination system. Your task now is to design an alternative method of organizing and staffing the fire support structures to optimize fire support coordination and integration.

- Develop a scenario that incorporates some change to the environment surrounding the fire support system. Some examples would be to build a scenario around the introduction of an expert system or decision aid. Another example would be to alter the threat to a point where the current architecture needs adjustment.

- Using this scenario as a point of departure design an alternative architecture for the fire support process that is capable of coordination and integration given a technological change or a changing threat.

- Identify the formal coordination mechanisms or liaison devices required at each location in the fire support structure and processes.

VI. MEASUREMENT OF ALTERNATIVE SYSTEM

A. BACKGROUND

Now that a different architecture has been developed, the final question is how to determine which architecture is better. This is the most important and probably the toughest question to answer. How is it possible to measure the effectiveness or efficiency of the architecture? Is it a quantitative or a qualitative measure? To begin with let's start with a simpler breakdown of the duties and responsibilities of the fire support system. This will then allow the development of measures that evaluate the merit of the architecture. All of the traditional stated duties involving coordination can be boiled down to three simply stated axioms:

- To ensure friendly fires do not harm friendly personnel or equipment.
- To ensure maximum efficiency in the use of supporting arms.
- To accomplish the above goals without unnecessarily hindering or delaying the destruction of the enemy. [Ref. 14:p. 3-1]

These are obviously not the only important responsibilities but the evaluation must begin somewhere, and these three axioms represent the major processes. Keeping these three axioms in mind, the next step is to formulate some measures that will investigate the performance of the architecture.

B. MOP, MOE, MOFE

A method often used in the field is the initiation of measures that assess the performance, function, and effectiveness of a system. The following are definitions of these measures.

1. Measures of Effectiveness (MOE)

A quantitative expression of the extent to which a combat system or a weapon performs its mission assignment under a specified set of conditions. MOE's are the criteria that are common to the evaluation of all competing alternative systems and are used to evaluate each system in terms of objective attainment. It is a measure of how well the command and control system performs its functions within an operational environment. MOE's measure the integration of all command and control functions of the process. Some examples of the types of things MOE's focus on: sensor detections, number of targets identified, number of targets engaged. [Ref. 15:p. 5-19]

TASK: Develop at least one MOE for an architecture

2. Measures of Performance (MOP)

A quantitative expression of how a combat system or weapon functions under a specified set of conditions. They are used to measure how well a particular function of a command and control process is executed. Due to the interaction between system performance and combat events, MOP's and MOE's are interrelated. While MOE's relate to the

overall combat results achieved, the MOP's relate to the manner in which the individual sub-systems and elements contribute to those results. Some examples of MOP's are: reliability, survivability, cost, error rates, signal-to-noise ratio, detection range, and location accuracy. [Ref. 15:p. 2-6]

TASK: Develop an MOP for an architecture.

3. Measures of Force Effectiveness (MOFE)

A measure of how a command and control system and the force (sensors, weapons, command and control structure) of which it is a part, performs its mission and contributes to the battle outcome. MOFE's relate the command and control system to the force, including weapons capability. [Ref. 15:p. 2-6]

TASK: Develop an MOFE for an architecture.

MOE's are measured relative to some standard. This means there is some known standard of how a perfect system would function. This then allows for a comparison between the designed architecture and a perfect situation. Theoretically, given a perfect command and control system, we would expect to identify every hostile target, make the correct decisions for attack, and destroy each target. [Ref. 15:p. 2-6]

A distinction should be made between the terms MOE and MOFE. The reason is that other factors contribute to whether an improvement in a system MOE results in

improvements in an MOFE. For example, increasing target detections (MOE), will not have much effect when no further ammunition is available to the weapons. Relating MOE's to MOFE's and consequently being able to evaluate a command and control system is a very complex issue. It should be noted that MOE's themselves, as well as MOFE's, are related to the operational context of the mission and to assumed enemy actions. This means they are both inherently scenario dependent. [Ref. 15:p. 2-7] MOE's and MOFE's are based heavily on judgmental decisions. Even when they have quantitative results there are judgmental decisions made that can greatly influence the results. [Ref. 15:p. 2-7] For example, the number of targets identified is a quantitative measure. This measure can be heavily influenced by decisions concerning boundary of the area sensed, sensitivity and time constraints, or mode of operation.

MOP's, in most cases, are quantitative measures and are related to the hard sciences (engineering) and can be measured or estimated. On occasions they can be subjective and qualitative. An example of this would be an ordinal ranking by a panel of experts. [Ref. 15:p. 2-7]

C. MEASURE DEVELOPMENT AND EVALUATION

The following are some examples of the factors to look at in regards to the development of MOE's and MOFE's. One of the first items to be considered is the environment in

which the system operates. The fire support coordination system is typically called upon to operate in a variety of environments. These range from amphibious to ground, nighttime to daytime, and limited war to large-scale warfare. One item to assess is how well does the system perform in each of these environments. Since the fire support system must function in a number of different environments, a better measure might be its ability to gracefully transition from one environment to another with a minimum loss of continuity or degradation in effectiveness. [Ref. 16:p. 9]

Another possible measure is to monitor the cycle time of components of the system. This means the elapsed between events is measured in order to determine responsiveness. An example of this would be to measure the cycle time between the sensor detection of a target and the physical attack of the attack. [Ref.16:p. 9] The cycle times performance could also be measured in different environments.

Once the measure is developed the next step is to evaluate it. One of the best ways to evaluate the types of measures involved in the fire support system will be through the conduct of a field experiment. These can entail actual field exercises or command post exercises (CPX). A possible outcome of these methods is the development of a simulation (computer model) that represents the processes of

the fire support system. Field experiments can be defined as combat simulations with the following characteristics:

- Actual physical representation of opposing forces with conflicting combat objectives.
- A setting in the actual or analogous environment.
- The inclusion of trained military personnel.
- The use of actual or surrogate equipment.
- The involvement of a control mechanism (umpires) to enforce the rules, and a data collection mechanism (instrumentation). A computer may be an integral part of this control mechanism. [Ref. 17:p. 269]

Field experiments serve two purposes; they produce data about the system and they provide operational training for the unit. A field experiment is useful to the trainer in developing new and better training methods and in measuring their effectiveness. It can be used to evaluate and compare the relative effectiveness of two or more ways of organizing a combat unit. [Ref. 17:p. 271] This fits the requirement for measuring the advantages of an alternative fire support architecture.

The field experiment is not a panacea for evaluating a command and control system. The most obvious disadvantage is the cost of conducting a field experiment. Conducting any exercise that involves the use of large numbers of personnel and equipment results in excessive cost. Another limitation is the extent of realism that is portrayed by the opposing force. Are they really representative of an enemy or do they just mirror our tactics? [Ref. 17:p. 276]

D. EFFECTIVENESS VERSUS EFFICIENCY

The final significance from the analysis of an alternative architecture is whether or not there is a gain in organizational effectiveness or efficiency. Effectiveness and efficiency are related to the units goals. The goals of an organization are the formally defined outcomes that an organization states it is trying to achieve [Ref. 9:p. 289]. These are analogous to the three mission statements of the fire support system stated at the beginning of the chapter. Organizational effectiveness is defined as the degree to which an organization realizes its goals. Effectiveness evaluates the extent to which multiple goals are attained. [Ref. 9:p. 98] The term effectiveness is used to refer to the organizations ability to maximize outputs by whatever means, including the technical efficiency of its processes and its management of input and output environments. Measures of effectiveness were discussed earlier and are a criterion used to determine effectiveness. An effective process is one that produces outputs that best meet the needs of the combat organization. [Ref. 18]

The term efficiency is different from effectiveness. Efficiency refers to the costs incurred in goal attainment. Efficiency can be measured on the average by the ratio of the units produced to the costs required to produce those units. An example would be the amount of ammunition used to

destroy a target divided by the costs (time, money, manpower). An efficient use of resources is one that produces the most output for the specified level of resource usage, given a physical and organizational technology. An organization is either efficient or it is not. [Ref. 18]

The major difference between effectiveness and efficiency is that effectiveness relates to goal attainment while efficiency refers to the costs incurred to obtain those goals. In general an effective output is efficient, but not all efficient outputs are effective.

VII. SUMMARY

Undoubtedly, comprehension of C2 system architecture theory is an important issue to be addressed in today's military structure. It is important to understand the principles and concepts involved in systems architecture. Additionally, it must be possible to discern the C2 processes that operate within the architecture. The contents of this thesis as regards to definitions, processes, architecture description, case formulation, and evaluation should serve as a common point of departure towards the discernment and analysis of a system architecture. Comprehension of system architecture theory is vitally significant if innovative designs of new systems or the redesign of existing systems is expected. The system architecture must be continually assessed to ensure that it maintains pace with the ever increasing upgrades in technology. As constraints on the defense dollar become tighter and tighter the need for increased effectiveness from our systems is critical. A major step towards attaining this is to have a complete understanding of system architecture theory. Further research is needed in areas dealing with the design of specific system architectures and with models that evaluate their relative effectiveness and efficiency. A technical framework for the definition,

design, specification, and integration of system architectures is needed to allow for their productive implementation.

This thesis has sought to present a basic introduction to the theory of system architecture. Additionally, it has used a current system to illustrate the concepts. Further, it has hopefully identified the importance of system architecture theory to future designs and towards the enhancement of existing designs.

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